

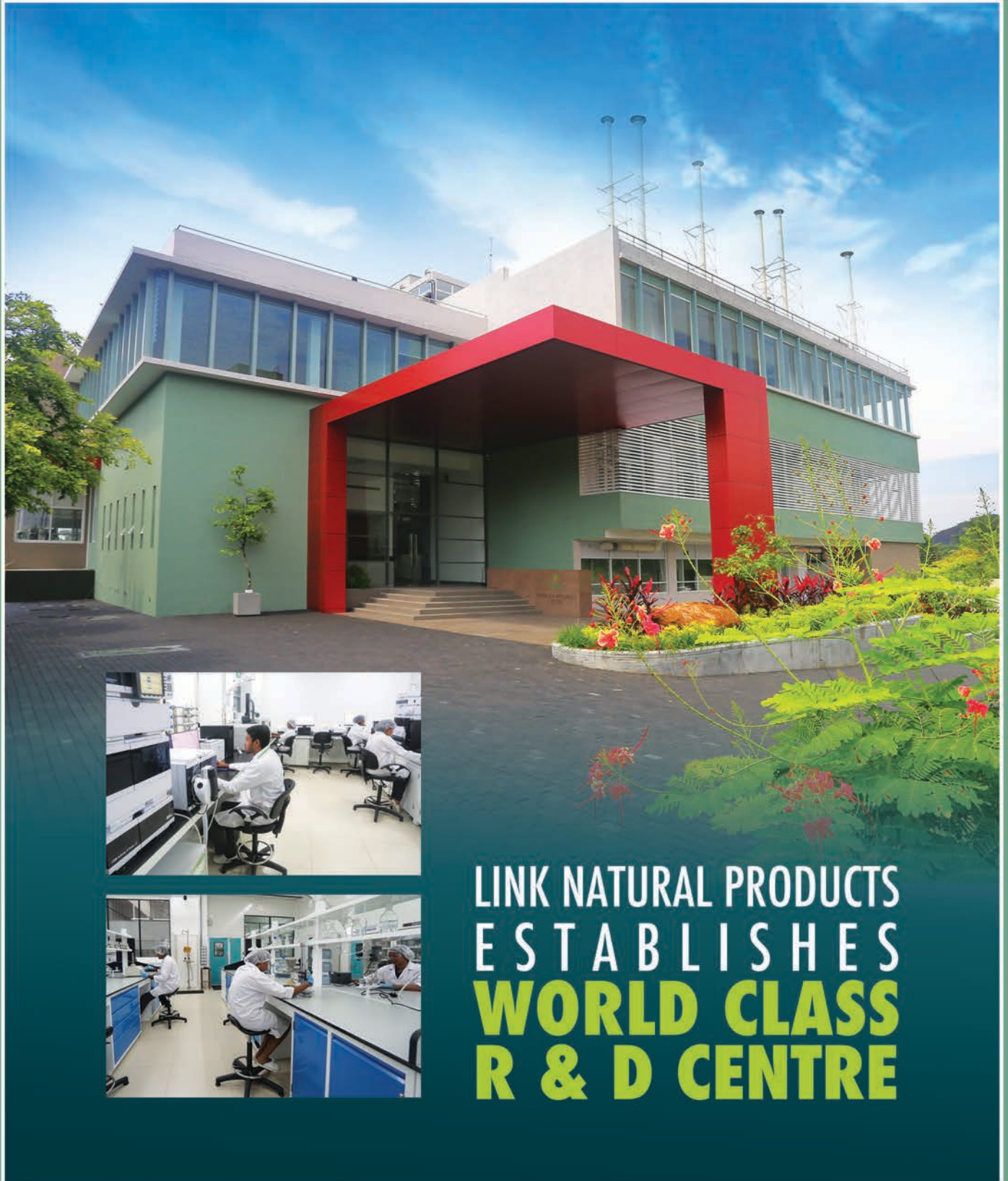


Link Natural

DIGEST

Volume.15, Issue 2, 2019

LINK NATURAL PRODUCTS (PVT) LTD



LINK NATURAL PRODUCTS
ESTABLISHES
WORLD CLASS
R & D CENTRE



Link Natural

DIGEST

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EDITORIAL

With the burgeoning of the Internet facility globally, a moot question is whether information retrieval through conventional print media, is fast becoming an anachronism. This is the subject of many discourses among information providers the world over. However, no consensus has been reached although the weightage seems to be towards the former. Following upon this, the Link Natural Digest, maybe also be history if the readership is diminishing. Presently, the many positive comments we receive is most encouraging and the Editors will strive to bring you more to titillate your interests. It may thus be timely, to lay down the intended purpose of this publication.

The Digest is intended to cater to the scientific and research mind as well as to the informed general public. It provides an awareness as to the benefits accruing from a natural lifestyle and natural health remedies drawing upon the nature's multitude of resources, and the prescience

of our forefathers in garnering these resources to provide effective systems of medicine for the people. It does not claim to be an original research publication, but rather attempts to tantalise the genuine researcher into pursuing promising areas of research which could ultimately provide natural drugs for the wellbeing of the people. Towards this end the Digest highlights natural resources which have accepted medicinal value and to the research carried out on them, through gleaning of relevant literature.

Being an organizational publication, naturally, some attention is also paid to the activities of the company, its achievements and its presence in the global market.

It is our hope that the Digest will give you much food for thought and stimulate your interests into knowing more about what nature provides.

Dilmani Warnasuriya

*If you wish to receive a copy of the Link Digest,
Please e-mail your request to info@linknaturalproducts.com*

LINK NATURAL PRODUCTS ESTABLISHES WORLD CLASS R & D CENTRE

Link Natural Products (Pvt) Ltd., makers of renowned brands such as Samahan and Sudantha has taken another pioneering step in establishing a world class Research & Development Centre.

The Centre was opened on the 22nd August 2019, in the presence of a large gathering of both past and present staff, Board members of the company and consultants and well wishers.

The Chief Guests on this occasion were Dr. R.O.B Wijesekera, the senior most consultant to the company, Mr W.M. Jayawardene, a consultant and a pioneer of the company and Mr. Sohli Captain, a distinguished industrialist. In the selection of Chief Guests, it was apparent that the Chairman wished to acknowledge the invaluable services of those who contributed towards the establishment of the company in 1982. (See box on page 05)



Dr R.O.B. Wijesekera and Mr W.M. Jayawardene at the Opening Ceremony

This modern facility has a full range of state-of-the-art equipment and laboratory facilities required for high level basic and applied research. It is manned by trained, experienced and skilled scientists supported by a team of advisors and experts. With the commissioning of this purpose designed facility, Link Natural Products has enhanced its capabilities for pioneering research and innovative product development to a truly international level. The company is well poised to transform the development of nature-based health and wellness products to levels hitherto unrivaled in Sri Lanka.

A multitude of natural health and wellness remedies are already in use across the world and are increasingly sought after. Yet, nature's vast potential for such products remain largely undiscovered, untapped and unavailable to a majority of people. In keeping with its philosophy of fusing the wisdom of Ayurveda and other traditional systems of medicine with modern science and technology, this new R&D Centre aims to tap into nature's abundance and discover new pathways and processes that will help innovate and develop safe and efficacious health and wellness solutions.

Dr. Devapriya Nugawela - Founder, Chairman/CEO of Link Natural Products, in his welcome address at the opening said, "apart from discovery and innovation, an essential requisite in developing nature-based solutions is to conclusively prove the efficacy and safety of ingredients and end products to meet regulatory standards and requirements of each country. Also, product claims and claim support need scientific validation. This calls for using internationally recognized scientific testing protocols and conventions to provide the necessary evidence and proof. The launch of this new R&D Centre enables Link Natural Products to meet these requirements and develop new and better natural health and wellness solutions and in so doing become a significant player in herbal healthcare and wellness industry globally."

This R & D Centre has the resources and capabilities to generate the wide spectrum of knowledge and data necessary to ensure that only the authentic and high quality plant material is used in the manufacture of products and to ensure that products manufactured by Link Natural Products will always meet the highest standards of safety and quality. The centre also has a fully equipped pilot plant which is essential to establish the processes for making new products developed in the laboratory, so that they can be scaled up for industrial manufacture.

The comprehensive library and archives along with the auditorium will provide researchers, scientists, and academics the facilities for knowledge enhancement and much needed dialogue and discourse. This centre will also function as a knowledge hub for exploration and advancement of the science of natural products. It will provide access to many; from global bodies seeking specific natural solutions to local companies and to universities desiring to further the knowledge and understanding of nature-based solutions. Commenting further, Dr. Devapriya Nugawela said; "Sri Lanka is rich in biodiversity and has a long and well-documented history in the use of plant material for health and wellness purposes evidenced by thousands of years of knowledge and practice of Ayurveda and Desheeya Chikitsa, and can be a significant global player in this industry. However, much remains to be discovered and learnt about the secrets of nature and its true potential before developing new products with health and wellness benefits. One of the principal activities of this new R&D Centre is to enable these endeavours."

With this world class R&D Centre, Link Natural Products aims to transform the innovation and development of nature-based wellness solutions and make them readily available in Sri Lanka and the world over and enhance its reputation as a leading maker and marketer of safe and efficacious natural healthcare and wellness products.



*Link Natural Chairman/Managing Director
Dr. Devapriya Nugawela*



*Link Natural Director - Research & Development
Mr. T.M.S.G Tennakoon*

A brief look at the engineering aspects of the Building by Malkanthi Perera

Construction of the Research and Development Centre at Dompe commenced on 17th April 2017 and was completed in 2019.

Foundations to the building was on independent and combined footings, with column, beam, slab structure in reinforced concrete, with brick walls mainly on the periphery of the building. Doors and windows are in powder coated aluminium and glass. Floors are mainly tiled with epoxy flooring and cement cut and polished in some selected areas. Entrance to the building has a glass curtain wall with an aluminium cladded entrance porch.

The Building has several levels, a lower level, ground and upper ground levels, first and second floors and a roof top with a total floor area of 4350 square meters (excluding the roof top). The Lower level consists of the Instrumental Analysis Unit I, Standardization and Regulatory Standard Development Laboratory, Microbiology Research Laboratory and service areas. The reception area and pilot plant are situated on the Ground level. The Upper level consists of Herbal Health Care Product Development Laboratory, Herbal Personal Care Products Development Laboratory, Pharmacognosy Laboratory, Instrumental Analysis Unit II and the consultant bay. The First floor incorporates the auditorium, Administrative areas, and R & D Library & Information centre with glass curtain walls overlooking the factory premises. Second floor is reserved as a future development area.

Services available are air conditioning (in most areas), Raw power and UPS power supply, Lightning protection system, Gas supply, Data and WIFI, CCTV and Public address system, Access Control doors, Multimedia system for the auditorium, Fire detection and protection system, goods and passenger lifts, water sump of capacity 30,000 litres and a waste water collection sump of 16,200 litres.

Internal partitions in lab areas are done with Glass Magnesium sandwich panels and ceilings in EPS foam sandwich panels. The Auditorium has a seating capacity for 70 and is completed with solid timber chairs with acoustic panelled walls and cement cut and polished floors.

The Drive and parking areas are paved with interlocked cement paving blocks on a bed of sand, with a geotextile membrane and 300 mm thick coarse aggregate base. This system eliminates the need for storm water drains, as the total precipitation is contained within the aggregate base functioning as a temporary ground water reservoir.

Pioneers of Link Natural Products

Dr. R.O.B Wijsekera

Dr. R.O.B Wijsekera a renowned scientist and a winner of the prestigious Guinness Award for Scientific Achievement bestowed by the Commonwealth Science Council, lent his expertise to the setting up of Link Natural Products, a company dedicated to carry out Natural Product Research aimed at developing herbal health care products from locally available raw materials. A poignant recollection of the Chairman Dr. Devapriya Nugawela is that it was Dr. Wijsekera's intervention that enabled him to clinch his first foreign sale for the initial consignment of essential oils distilled by the company, when all attempts to do so failed. It is also pertinent that these buyers introduced by him have remained a regular clients of the company ever since. Dr. R.O.B. Wijsekera was then stationed in Geneva on a WHO assignment. Subsequently he joined UNIDO in Vienna as a Special Technical Advisor on Essential Oils and Medicinal Plants for a period of ten years, after which he returned to Sri Lanka to serve his motherland. Dr. Wijsekera, functioned as the Chairman of the Industrial Technology Institute (formerly CISIR) and then of the newly set up NASTEC, (National Science and Technology Commission).

Mr. W.M. Jayawardene

Mr W.M. Jayawardhane, was one of the key persons instrumental in setting up the company in 1982. Mr. Siripala Jayasinghe was the Chairman of Link Engineering and he, along with Dr. Devapriya Nugawela and others was able to set up Link Natural Products under this parent company. After the demise of Mr. Jayasinghe in 1988. Mr. Jayawardhane succeeded him as Chairman of Link Engineering. Due to the rapid progress made by the company, Link Natural Products was able to become a separate entity subsequently. Mr. Jayawardhane was a pioneer and visionary who saw the immense potential of such a company. He also developed a live herbarium of medicinal and aromatic plants within the company premises with a view to educate and create awareness among students and researchers. Due to the exigencies of subsequent building activities, this live herbarium has now been replaced by a nursery consisting of medicinal and aromatic plants.

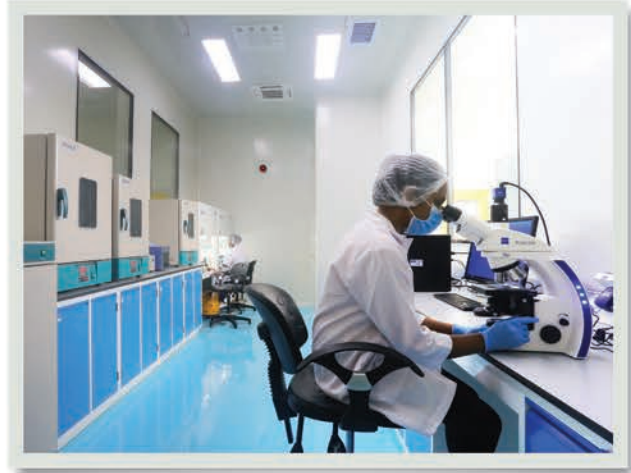
Mr. Jayawardhane, a reputed engineer himself, is also known for playing a major role in the construction of the much lauded pioneering eco hotel, Kandalama, through Link Engineering, the company he headed. He worked alongside the world famous architect Geoffrey Bawa in this venture. The hotel is renowned for its environmental friendly nature and this is an area close to his heart. Mr Jayawardene continues to function on a consultancy capacity at Link Natural and is a valuable contributor to the progress of the company.



External view of the Centre



Standardization and Regulatory Standard Development Laboratory



Microbiology Research Laboratory



Pilot plant



Herbal Personal Care Products Development Laboratory



Instrumental Analysis Unit II



Herbal Health Care Product Development Laboratory



Pharmacognosy Laboratory



Instrumental Analysis Unit I



Instrumental Analysis Unit I



Auditorium



Library and Information Centre



Library and Information Centre

SPONGES - WITH VIVID HUES AND HIDDEN MEDICINAL AGENTS

R. O. B. Wijesekera and Dilmani Warnasuriya

Preamble

Sponges, as we know it, is a term commonly used to refer to porous cleaning or rubbing materials, and also to a bath accessory. Originally, sponges referred to actual living aquatic creatures, belonging to a most primitive group of invertebrate animal organisms, (Figures 1&2) but this fact is little known, as synthetic sponges have now dominated the market.



Figure 1



Figure 2

Sponges in use today are for the most part, thus synthetically produced and the intricate architectural structure with its extensive pore system and soft skeletal tissues replicates that of actual living animal sponges.

An example of bath sponges made from actual sponge organisms is shown in Figure 3.



Figure 3

The commonly used loofah as a bath accessory closely resembles a natural sponge.

Sponges are a renewable natural source when harvested with the base intact. They can regenerate rapidly, and occupy a vast area on the ocean bed, bestowing upon it the enthralling vivid colours much admired by oceanologists. With the movement of tides and waves they are also able to acquire new territory for growth. While synthetic sponges are gaining popularity, it is an undisputed fact that natural sponges are

far superior in actual use, being highly absorbent, soft and creates a luxurious lather. Its texture is thus most suitable for sensitive and delicate skins, particularly babies. Another advantage is that natural sponges are longer lasting than the synthetic sponges, as they have enzymes that inhibit the growth of moulds, bacteria and mildew, unlike synthetic sponges which are prone to disintegration due to the action of these organisms. They also soak up and hold more water without dripping. Sea sponges are also self-cleaning through their intricate system of canals where there is continuous circulation of water. Thus, they do not retain any bad odours.

Sponges are said to be survivors of the Precambrian seas, having arrived here from an ancient world. Their sessile nature and perforated appearance belie their inclusion in the animal world, but in reality, sponges predate all currently living animals on earth. They are the only animals to have parts of their DNA sequences present in every other animal below and above water. As mentioned, natural marine sponges are a group of the most primitive invertebrates in the animal kingdom, scientifically referred to as Porifera. The name signifies its pore bearing nature as sponges have bodies full of pores or channels permitting the flow of water through their bodies. They live in a wide array of aquatic environments from deep ocean depths to shallower waters, tropical seas to arctic seas, rivers and streams. Over 8,000 species of sponges are known, of which about 150 live in freshwater. Sponges have a unique filter feeding system taking its food consisting of microscopic organisms such as protozoa, bacteria and organic material from the flowing waters.

This type of feeding system requires a solid support, and thus sponges are found on rocky areas on the ocean floor and are an integral part of the ecosystem of coral reefs, being responsible for the vivid hues of coral reefs. Sponges have also an unusual cell structure, where the different cells have different tasks but do not form tissues, and they come in varied shapes and sizes, some being tubular, globular, cup-shaped, plant-shaped, fan-shaped, cone shaped and amorphous.

Bioactivity of Sponges

Marine invertebrates are known to possess many valuable bioactive compounds which could be exploited for the use of drugs. Porifera or sponges, have occupied pride of place as far as the presence of biologically active compounds are concerned. How are these compounds formed? Researchers found that sponges have thousands of defensive chemical weapons or secondary metabolites for their protection. Defence against predators, poisoning, infections, pressure from competitors for space are some of the pressures faced by sponges, and to circumvent these threats they have armed themselves with an arsenal of potential chemical defence agents. Research suggest that these secondary metabolites have promising potential to provide future drugs which can serve effectively against various diseases. Some of these are already in the advanced stage of drug development or poses clear indications of being possible drugs. The diversity of these chemicals is indeed amazing. They range from derivatives of amino acids and nucleosides to macrolides, porphyrins, terpenoids to aliphatic cyclic peroxides and sterols. A three pronged approach has been used to study chemical ecology of sponges, namely, diversity of chemical compounds produced by sponges, potential functions of these metabolites in nature and strategies for their use for human benefit.

Bioactive compounds with drug potential

Marine sponges have proved to be one of the richest sources of antitumor agents and several sponges derived compounds are being clinically evaluated from their drug potential.

A typical example of a promising marine derived anticancer agent is erybulinsilate a derivative of halycondrin B isolated from the marine sponge *Halychondria okadai*. This is now in phase III clinical trials. Other sponge derived pharmaceutical drugs isolated from *Cryptotethya crypta* are the spongothymidine and spongouridine nucleosides, which were among the first successful ventures. Antiviral properties of these nucleosides were demonstrated

subsequently, and this prompted researchers to synthesize analogues of these compounds which then led to the first antiviral compound Ara-A, a semisynthetic compound, based on the arabinosyl nucleosides, that inhibits viral DNA synthesis. and which was active against Herpes virus. An anti-tumour compound Ara C (Arabinosyl Cytosine) effective in acute lymphoid leukaemia was also developed. The compounds Ara-A and Ara-C are the only marine invertebrate-related compounds in clinical use. Ara-C in combination with other anticancer drugs, is being screened for the treatment of acute myeloid neoplasma. Compounds isolated from marine sponges which displayed antiviral activity include 4-methylaaptamine, avarol, manzamines, mycalamide A and B.

In fact, preclinical assessments were also started for avarol and manzamine A. It can be said however, that in general, antiviral molecules from sponges do not give protection against viruses, but they may result in drugs to treat already infected individuals.

Crude extracts of marine sponges have also shown high antibacterial activity against some types of bacteria. A wide range of active chemical compounds, many of which have shown positive results have been identified.

Around 850 antibiotic constituents are reported from marine sponges. However, none of them have reached a commercial production stage, although manzamine A and psammaphin A are in preclinical trials.

Marine sponges are also known to yield many anti-inflammatory compounds and natural anti-oxidants. Manolide from the Palauan sponge *Luffariella variabilis* is one such example. Anti-inflammatory compounds found in the marine sponges include terpenes, alkaloids and steroids. Some extracts from marine sponges are now also being screened for immunomodulating activity and enzyme inhibitory activity as well. The compounds effective in the latter were found to be quinones, Cyclostellamines and fatty acids.

The vast range and diversity in the use of compounds from marine sponges is indeed amazing. Pure compounds showing immunosuppressive activity were isolated from the deep water marine sponge *Agelasflabelliformis*. Studies on this are presently in progress.

Other studies attempted to isolate and characterize bacteria from a marine sponge with immunomodulatory and anti-microbial activity.

Table 1. Some of the sponge-derived bioactive products, which are currently in market or in clinical phases

Product	Application area	Status
Ara-A	Antiviral	Market
Ara-C	Anticancer	Market
Manoalide	Molecular probe: phospholipase A2 inhibitor	Market
IPL512602 (Steroid)	Anti-inflammatory/ asthma	Clinical phase II
Manoalide	Anti-inflammatory/ psoriasis	Clinical phase I
KRN 7000 (α -Galactosylceramide)	Anticancer	Clinical phase I
LAF389 (Amino acid derivative)	Anticancer	Clinical Phase I
Discodermolide (Polyketide)	Anticancer	Clinical phase I
HTI286 (Tripeptide)	Anticancer	Clinical phase I

Ten bacterial strains were thus isolated, and these showed a remarkable antagonistic activity against clinical bacterial pathogens. These findings are indeed encouraging and can contribute the search for novel antibiotics to overcome infections and for the production of potential immunomodulators.

Biofouling

Biofouling causes deterioration and instability of structures and devices submerged in the sea, thus causing heavy economic losses. Effective anti-fouling processes are thus a dire need. Presently, toxic biocides are used but severe environmental concerns have arisen in their use. Efforts are now being made to develop alternative eco-friendly anti-fouling compounds from marine organisms, sponges being identified as having great potential, directly and indirectly. As discussed, sponges produce secondary metabolites in their defence arsenal against predators and this prevents the settlement and growth of other organisms on their surfaces, and this is the strategy now being used. Already, some bioactive metabolites from selected sponges have shown significant anti-fouling activity

Another source of such metabolites is through a symbiotic relationship with other organisms, particularly bacteria, and this could be another source of bioactive material found in sponges. Through the swirling waters flowing through the tube like channels of sponges, bacteria are swept in and out, and some bacteria are retained in the sponge body. The biology of bacterium-sponge relationship has evoked considerable interest among researchers. It has been reported that these bacteria produce bioactive metabolites, and this could be an indirect source of anti-fouling compounds harvested from sponges

Harvesting and Cell culture

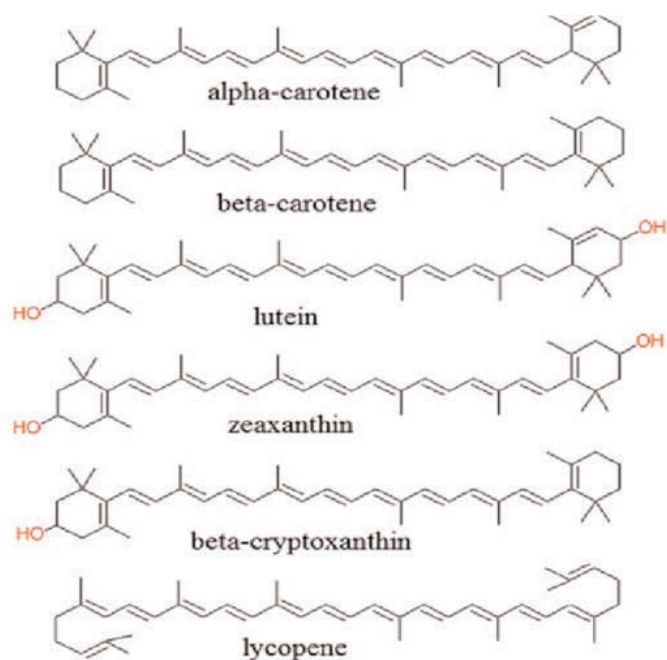
Sponge metabolites are produced only in trace amounts and vast amounts of sponge biomass is needed to extract the active compounds. Harvesting from the sea is not a practical solution, and thus supply problems stymie the development of many potential

bioactive compounds which could be used in several spheres. This has given the impetus to researchers to develop alternative methods of supply of sponge metabolites. A three pronged approach is being applied, these being chemical synthesis, laboratory cell culture and aquaculture and progress is being made in all three methods.

Hues of Sponges

The chemical entities that are responsible for the strikingly vivid colours displayed by the corals that comprise the marine sponges belong to the chemical class of compounds identified as "carotenoids". These compounds got their name from the original orange pigments of carrots from which they were first isolated. There are a great many colourful carotenoids and their number is ever increasing as new sources of coral and sponges come to be discovered. It must be pointed out that though the variety of colourful types within sponges and coral are many the variety of bioactive agents that the sponges provide are even more amazing, as these belong to many chemical molecular types.

Carotenoids now comprises of a fantastic array of compounds which include a wide number of variants of the original carotenoid theme. The parent structure of carotenoids is as follows.



These basic structures are the building frame from which the more complex structures of the colours of the sponges are derived. More studies are needed to fine tune the various chemical structures in the different colour compounds

Conclusions

These fascinating studies provides much fodder for the natural product chemist on his research journey. The immense potential and diversity of marine organisms, with sponges leading the way, is only too clearly highlighted. Different disciplines are however needed to fully exploit the wealth of compounds offered by these organisms for their potential as future drug providers. Apart from chemists, input from microbiologists and also molecular and cell biologists are also needed and concerted research should be initiated. This is a wakeup call for scientists.

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The greatest disease in the West today is not TB or leprosy; it is being unwanted, unloved, and uncared for. We can cure physical diseases with medicine, but the only cure for loneliness, despair, and hopelessness is love. There are many in the world who are dying for a piece of bread but there are many more dying for a little love. The poverty in the West is a different kind of poverty - it is not only a poverty of loneliness but also of spirituality. There's a hunger for love, as there is a hunger for God.

- Mother Teresa, *A Simple Path*

“No man is brave that has never walked a hundred miles. If you want to know the truth of who you are, walk until not a person knows your name. Travel is the great leveler, the great teacher, bitter as medicine, crueler than mirror-glass. A long stretch of road will teach you more about yourself than a hundred years of quiet introspection.” -

Patrick Rothfuss, The Wise Man's Fear

There is new life in the soil for every man. There is healing in the trees for tired minds and for our overburdened spirits, there is strength in the hills, if only we will lift up our eyes. Remember that nature is your great restorer.

Calvin Coolidge

A SNAPSHOT OF THE PRODUCTIVITY AND SCIENTIFIC IMPACT OF NATURAL PRODUCTS RESEARCH CARRIED OUT IN SRI LANKA : A BIBLIOMETRIC ANALYSIS USING THE SCOPUS DATABASE

*Geethika Yapa**

Sri Lanka has a long history of work in the field of natural products. Being a repository of a rich variety of fauna and flora and having the highest diversity per unit area in Asia, research on natural products has been a fertile area for scientific investigations and has flourished in the country.

Study of natural products is an interdisciplinary field of science and encompasses the conventional fields of chemistry, biochemistry, biology, pharmacology, pharmacognosy etc. A large number of researchers and research groups from universities and research institutions have been engaged in these areas of research and have produced a wealth of information useful to mankind.

In view of the importance of natural products research in the national context, the current study aimed at assessing the productivity and scientific impact of research in natural products carried out in Sri Lanka during the 15 – year period, 2004 – 2018 through a bibliometric analysis.

The secondary data needed for this analysis was extracted from the SCOPUS abstract and citation database. SCOPUS, launched in year 2004 by Elsevier is an international, multidisciplinary database of peer – reviewed literature. It covers over 11,670 publishers worldwide and indexes nearly 34,350 peer – reviewed journals in the broad fields of Physical Sciences, Life Sciences, Health Sciences and Social Sciences. It further covers trade publications, book series and international conference/ seminar papers. All

these titles are classified under 20 subject categories under the above four fields. As this database has a large coverage of journals from developing countries, it was deemed an appropriate source for consideration as a secondary database for this study.

The productivity was assessed on the basis of the quantum of research articles and review papers in the international scientific literature. The scientific impact was based essentially on the basis of the frequency in which these papers have been cited by other authors world – wide.

This study also aimed to analyze, in detail the scientific impact of the natural products research output during 2004 – 2014, within a 5 – year citation – window (publication year and subsequent 4 years).

The publications authored by Sri Lankan scientists were selected by using “Sri Lanka” in the field of the “ Affiliation country’, together with “Articles and Reviews” in the field of ‘Document type’, within the period 2004 – 2018 of this electronic databases. This information was used to document the total research output of Sri Lankan scientists during this 15 – year period.

Thereafter, selectively clicking “Natural Products” within the previous search results, the information pertaining to natural products was extracted.

In the next step, by selecting the option of the ‘Citation Overview’, the citations received for

* Dr Geethika Yapa is a Senior Officer attached to the Journal Publication Division of the National Science Foundation of Sri Lanka.

this cohort of papers in natural products were obtained, in order to assess the scientific impact.

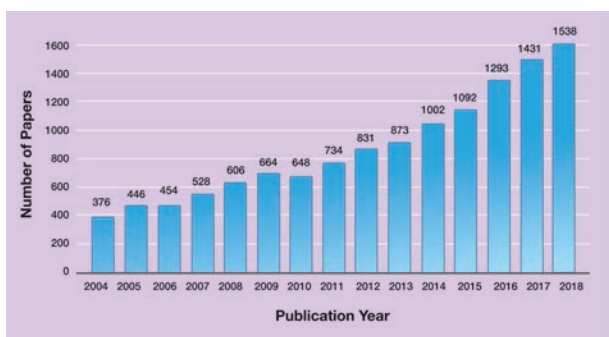


Figure 01:

Total papers (Research articles and review papers) authored by Sri Lankan Scientists during 2004 – 2018 (Source: SCOPUS)

As shown in Figure 01, during the period 2004 – 2018, a total of 12,448 research articles and review papers have been authored by Sri Lankan scientists. Out of these, 4437 (35.6%) papers had been published in open access journals, making local research results readily available to a global audience.

The research output (in terms of the number of research articles and reviews per year) has shown an increase from a meagre number of 376 in 2004 to 1535 in 2018. This is approximately a 400% increase demonstrating enhancement of productive research activities of our scientists.

The annual, average number of papers during this period was 829 and until 2012, the number of papers has been below average. However, a significant increase is seen from 2012, and this trend has been consistent during the subsequent years.

Overall, a continuous increase in papers has been observed except in 2010, where there has been a decline in the number of papers with respect to 2009. One reason for this reduction may have been the civil unrest during the latter part of 1980's which curtailed almost all activities in the country and brought civil life to a standstill. According to the classification used by SCOPUS, the highest share of publications comprising 4429 (35.9%) had been in the field of Medicine,

followed by Agriculture and Biological Sciences with 2315 papers (18.5%) and 1571 (12.6%) papers from research in Environmental Sciences. These findings are generally in line with the observations of Gupta (2012), who investigated the S & T publication output of Sri Lanka during 2001 – 2010 through a scientometric assessment using SCOPUS database.

Apart from the three fields mentioned above, Biochemistry, Genetics and Molecular Biology have a share of 1351 (10.8%) papers while Sri Lankan Social Scientists have produced a total of 1192 (9.6%) papers during this period of 15 years.

The current analysis reveals that the most productive institution in terms of papers, is the University of Colombo with 3574 (28.7%) papers. It is interesting to note that the Faculty of Medicine of the Colombo University had contributed 32% of these papers. University of Ruhuna's contribution was 1036 (8.3%) papers while Universities of Kelaniya, Sri Jayewardenepura and Moratuwa accounted for 1022 (8.2%), 782 (6.3%) and 590 (4.7%) papers respectively.

It is a noteworthy fact that Sri Lankan researchers had collaborated with counterparts from 160 countries in producing this research output during the 15 years. The highest productive collaboration had been with the USA with 1946 papers followed by the UK with 1894, Australia (1511), India (1206) and Japan (902).

On the other hand, research productivity in natural products, during 2004 – 2018 had been an output of 349 papers according to the SCOPUS database (Figure 2). While 322 out of these are research articles, 27 are scholarly material comprising review papers. Within this research output, 119 papers are in Open Access journals disseminating local research findings widely and bringing recognition to our scientists. It is noteworthy that while only 7% of journals in which Sri Lankan researchers opted to publish their findings comprise open access journals in 2004, this had increased exponentially to 34.4 %

by year 2018. This trend has no doubt brought more visibility to research results of scientists from developing countries.

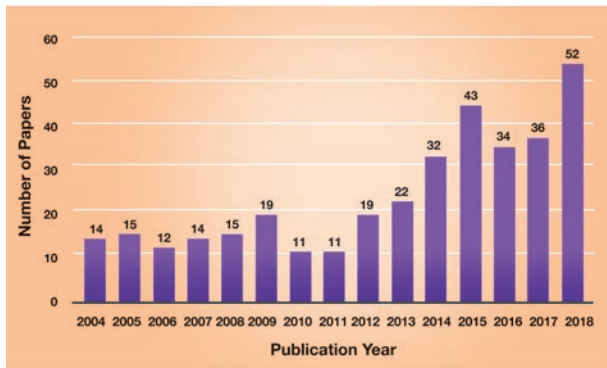


Figure 02:

Total number of Research Articles and Reviews in Natural Products during 2004 – 2018 (Source: SCOPUS)

When this research output is slotted into 05 - year time intervals, the publication output is shown to have increased from 74 during 2004 - 2008, to 82 in 2009 – 2013 and 197 during 2014 – 2018, displaying a healthy growth rate.

Our data further reveals that the 489 researchers involved in this research output are affiliated to 35 Institutions in Sri Lanka (12 universities and 23 S & T Institutions). The highest number of researchers (121) are affiliated to the University of Colombo (Figure 03). University of Peradeniya with 64 researchers, National Institute of Fundamental Studies with 59, the Industrial Technology Institute with 52 and the University of Ruhuna with 45 researchers are the top five Institutions that contributed to this share of 349 papers. These data show the research interests and the productivity of the natural products research groups in these institutions.

The secret of health for both mind and body are not to mourn for the past, not to worry about the future, or not to anticipate troubles, but to live in the present moment wisely and earnestly.

- A saying from the Buddha

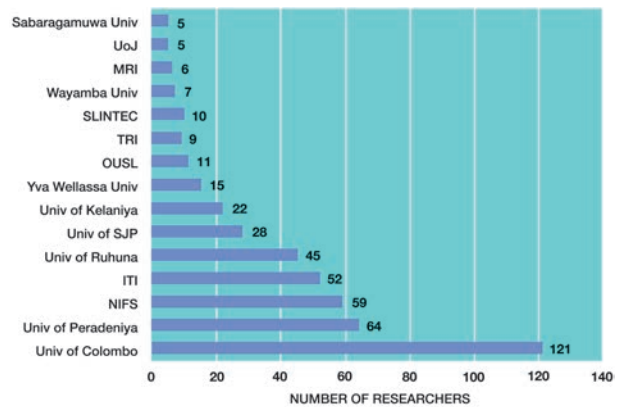


Figure 03:

Number of researchers by their institutional affiliation – the top 15 institutions (Source: SCOPUS)

When the scientific impact in the form of citations received for this set of 349 papers during 2004 – 2018 are analysed, the following can be seen:

- During the period 2004 - 2018, a total of 4038 citations had been recorded for the 349 papers from the date of publication till the end of the year 2018 (Figure 4).
- 67 papers had attracted over 20 citations
- 07 papers have been cited more than 100 times; the highest number of citations received for a paper is 186
- 40 papers had failed to attract any citations.

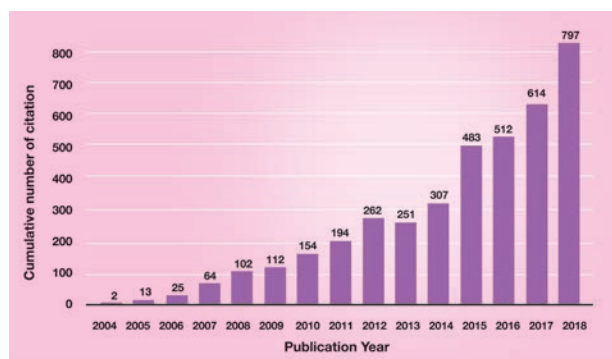


Figure 04:

Citations (cumulative) received for the papers in natural products from 2004 – 2018 (Source: SCOPUS)

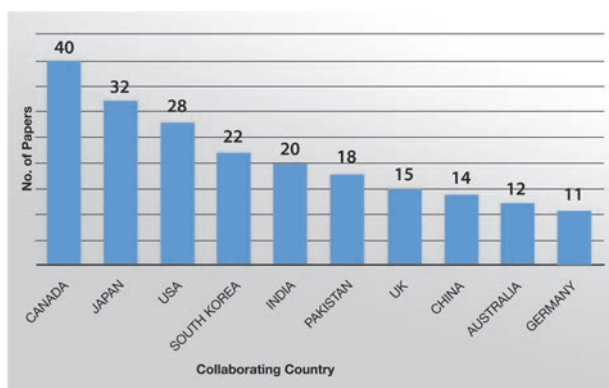


Figure 05:

Trends in the number of Papers arising out of International collaborations during 2004 -2018 (Source: SCOPUS)

Review of literature support that productivity and research impact increases with the increase in level and type of collaboration, with publications co-authored with foreign scientists attaining higher citation rates (Burke et al, 1999, Yapa et al, 2004).

We therefore investigated the types of collaborations that had been forged by Sri Lankan natural products researchers with international as well as local counterparts and colleagues. Four types of collaboration during 2004 – 2018 were identified as follows:

International Collaboration

Paper with several co-authors, where one or more are not Sri Lankan nationals and not residing in Sri Lanka

Inter-institutional collaboration

Paper with several co-authors, where one or more are from different organizations in Sri Lanka

Inter-departmental collaboration

Paper with several co-authors, where one or more are from different departments of the same organization

Intra – departmental collaboration

Paper with authors from the same department of the same organization

Publication Year	International Collaboration	Inter-Institutional Collaboration	Inter-Departmental Collaboration	Intra Departmental Collaboration	Total
2004	10	3	1	0	14
2005	6	4	3	2	15
2006	9	2	0	1	12
2007	10	0	2	2	14
2008	10	1	1	3	15
2009	11	2	2	4	19
2010	5	3	0	3	11
2011	6	3	0	2	11
2012	10	5	1	3	19
2013	15	3	4	0	22
2014	21	7	2	2	32
2015	18	17	3	5	43
2016	11	13	5	5	34
2017	24	7	1	4	36
2018	36	7	1	8	52
Total	202	77	26	44	349

Table 01: No. of papers in natural products in relation to the type of collaboration

With respect to international collaborations, Sri Lankan researchers have collaborated with counterparts from 46 countries in producing these 349 papers. The highest share of papers was from collaborations with Canadian scientists. S & T personnel from Japan, USA, South Korea, India and Pakistan have also contributed generously to this research output (Figure 05).

The following are also observed from our analysis on collaborations:

- 58% of all publications involved international collaborations.
- Except in years 2005, 2010, 2015 and 2016, the papers arising out of international collaborations outnumber the papers resulting from local collaborations.

- The highest number of papers with international collaborations was seen during the last 05 years of the study period 2014 - 2018, but a drop was seen in 2016.
- In 2015 and 2016, papers arising out of local collaborations exceeded those arising from international linkages.
- Intra – departmental or “closed – circuit” research networks in Sri Lanka (13%) have not been very productive.
- A moderate 22 % of papers had resulted from Inter – institutional collaborations.
- Inter – departmental collaboration was only 7%, raising concerns on the lethargy of our research personnel to forge successful partnerships with their colleagues within their Institutions in carrying out multidisciplinary research.

When the journals in which the most number of papers have been published is analysed, it is interesting to note that the most preferred channel of communication of research results has been the Journal of the National Science Foundation of Sri Lanka with 28 papers. Recording a long history of 47 years and being the only journal in Sri Lanka indexed in the Clarivate Analytics, Science Citation Index Expanded (SCIE), it is not surprising that Sri Lankan researchers prefer to disseminate their local research results through the JNSF.

The next five most popular journals chosen by our researchers to publish their research findings, in descending order of number of publications are: Natural Products Research (19 papers), BMC Complementary and Alternative Medicine (18), Journal of Natural Products (13), Acta Crystallographica (12), Pharmaceutical Biology (10) and Journal of Ethnopharmacology (9).

Perusal of the 07 most cited papers during the period 2004 – 2018 reveal that except for one paper) arising out of local institutional

collaborations which had attracted 107 citations (17.8 citations per year), the other 06 papers are arising out of international collaborations.

Another highly cited paper (186 citations and 15.5 Citations per year) which had brought together 04 researchers from Singapore, China and Sri Lanka, discusses a unique therapy for the treatment of neurodegenerative disorders such as Alzheimer’s Disease and Ischemic Stroke.

An investigation of the flavonoid biosynthesis in *Camellia sinensis* carried out by researchers from the Tea Research Institute of Sri Lanka in collaboration with University of Peradeniya and a group of scientists from the University of Munich and Philipps University Marburg, Germany, had attracted 127 citations since 2004 (8.5 citations per year), reiterating the importance of this valuable natural product, flavonoids in the staple Sri Lankan beverage, tea.

Investigations on bioactive metabolites from macrofungi (17.8 citations per year), medicinal properties of cinnamon (17.7 citations per year) and essential oils as potential antimicrobial agents (20.3 citations per year) had also attracted a total of over 100 citations from the year of publication up to the end of the year 2018.

When the funding organizations which have provided financial support for research activities leading to this rich output of papers in natural products are analysed, it can be seen that out of a total of over 75 funding organizations, 09 sources in Sri Lanka have productively contributed to this output. The most number of grants have been awarded by the National Research Council (30 grants) followed by the National Science Foundation and NARESA (24), University of Colombo (6) and the University Grants Commission (4) grants.

For a detailed analysis, we selected the set of publications during 2004 -2014, to map the citations received during the first 05 years. This 05 – year citation window (publication year plus

the 04 subsequent years) was selected in view of evidence in literature that typically most papers will have received approximately 50% of citations during the first 5 years (Katz & Plevin, 1988).

It has also been reported in literature that the average publication reaches its peak citation rate during the third year of its lifetime (Glanzel et al 1995).

Publication Year	Total Papers	Total Citations	Citations per paper	Total Citations				
				1st Year (Publication year)	2nd Year	3rd Year	4th Year	5th Year
2004	14	84	6.0	2	10	17	22	33
2005	15	87	5.8	3	8	21	24	31
2006	12	114	4.2	1	21	33	22	37
2007	14	80	5.7	4	19	17	21	19
2008	15	82	5.5	3	13	15	26	25
2009	19	154	8.1	2	23	36	56	37
2010	11	98	8.9	4	17	27	28	22
2011	11	57	5.1	1	6	9	19	22
2012	19	219	11.5	10	23	51	71	64
2013	22	369	5.2	7	49	98	101	114
2014	32	192	6.0	10	35	52	48	47
Total	184	1536		47	224	376	438	451

Table 02: Trends in citation intensity during first five years of publication

As per Table 02, there was no consistent performance for the citation peaks observed in the current study for the 184 publications. The total number of citations had fluctuated. Even though the highest number of citations was seen in year 2013, this cannot be considered as a significant achievement since the citation rate this year has been the lowest after 2011, during the period under consideration. It is however noted that for papers published during the five years

(2007, 2008, 2009, 2010, 2012), the citation intensity peaked during the 4th year. For papers published during 2004, 2005, 2006, 2011 and 2012, the peak year had been the 5th. The significance of this observation though not obvious at present, may possibly be explained in an extended study, when trends in natural products research priorities nationally and internationally, are taken into consideration.

Type of Collaboration	No. of papers	As a percentage	No. of citations for first five year lifetime	Citations per paper
International	114	62 %	995	8.7
Inter – institutional	31	17%	140	4.5
Inter - departmental	15	8%	66	4.4
Intra - departmental	22	12%	60	2.7
Single author	2	1%	18	9

Table 03:
Effect of type of collaboration on citation rate for papers published from 2004 – 2014

From Table 03, it is evident that the international research collaborations had been scientifically, the most impactful and is far ahead with respect to the papers arising out of local collaborations when citation rates are considered. This brings to attention the lack of or inadequate research infrastructure and advanced laboratory facilities that hamper our R & D activities. By consolidating on the productive international linkages, it is possible to build up and enhance the domestic research base.

In conclusion, this preliminary study conducted using secondary data from the SCOPUS database gave a glimpse of the productivity and scientific impact of natural

products research during a period of 15 years. A more in depth investigation taking into account the H – index of the researchers, their institutions, the publishing journals as well as an author – keyword analysis to demonstrate research trends and frontiers is needed to comprehensively assess the natural products research landscape of Sri Lanka.

Acknowledgement: Author is grateful to the National Science Foundation of Sri Lanka for providing access to the SCOPUS database and Mrs Renuka Sugathadasa for assisting with data retrieval.

All one needs to do is read - books, magazines, research the Internet - and pay attention to the influencers in their lives to discover the myriad people of strong moral character who have and still are making positive, meaningful contributions and differences in our world.

Zig Ziglar

Nature is full of wonders; every atom is a standing miracle, and endowed with such qualities, as could not be impressed on it by a power and wisdom less than infinite.

Joseph Addison

Having a healthy mind is just as important as a healthy body.

MURUNGA (MORINGA OLEIFERA) THE “MIRACLE” PLANT

By Anura Senaratne*

Moringa oleifera is a fast-growing, drought-resistant tree of the family Moringaceae, native to tropical and subtropical regions of South Asia. Common names include moringa, drumstick tree, horseradish tree, ben oil tree or benzolive tree. The people in these regions consume moringa leaves and pods as a very popular vegetable in their routine daily meals. In Sri Lanka, moringa (murunga, Sinhala) is grown as a common home-garden plant, but not as a commercial plantation until very recently. The natives make a delicious curry with moringa leaves and pods to accompany their cooked rice meals.



Murunga leaves and pods

The moringa tree is grown mainly in semiarid, tropical, and subtropical areas particularly suitable for dry regions. In Sri Lanka, the moringa tree grows practically in all regions of the country, but it grows most prolifically in Jaffna and North-eastern and North central provinces. It tolerates a wide range of soil conditions, but prefers a neutral to slightly acidic (pH 6.3 to 7.0), well-drained sandy or loamy soil. In waterlogged soil, the roots have a tendency to rot. Moringa is a sun- and heat-loving plant, and does not tolerate frost or freeze. Unlike many traditional commercially grown agricultural crops, moringa can be grown using rainwater without expensive irrigation techniques. Moringa can be propagated from seeds or cuttings. Direct seeding is possible because the germination rate of *M. oleifera* is high. Moringa seeds can be germinated year-round in well-draining soil. Cuttings of 1 m length and at least 4 cm diameter can be used for vegetative propagation.

For intensive leaf production, the spacing of plants should be 15 x 15 cm or 20 x 10 cm, with conveniently spaced alleys (for example: every 4 m) to facilitate plantation management and harvests. High dense growth may pose problems in weeding and disease prevention. In a semi-intensive production, the plants are spaced 50 cm to 1 m apart. This gives manageable plantations with less maintenance.

Moringa trees can also be cultivated in alleys, as natural fences and associated with other crops. The distance between moringa rows in an agroforestry cultivation is usually between 2 and 4 m. In many parts of Sri Lanka moringa trees are grown as fences and the pods are used as the main harvest from the tree.

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Murunga Trees in a forest and harvested pods



Climate	Grows best in tropical or subtropical (temperature 25-35 °C)
Altitude	0-2000 m
Rainfall	250-300 mm Irrigation need for leaf production if rainfall < 800 mm
Soil type	Loamy, sandy or sandy loamy
Soil pH	5-9

Medicinal properties

In recent times, the plant has been studied for its health properties, these properties being attributed to the numerous bioactive components, including vitamins, phenolic acids, flavonoids, isothiocyanates, tannins and saponins, which are present in significant amounts in various parts of the plant. Moringa is often referred as a panacea for all ills because

it is known to cure more than 300 diseases. *Moringa oleifera* leaves are the most widely studied and they have shown to be beneficial in several chronic conditions, including hypercholesterolemia, high blood pressure, diabetes, insulin resistance, non-alcoholic liver disease, cancer and overall inflammation. These scientific findings promoted a high demand for moringa products in European and American markets. The strong antioxidant properties ascribed to moringa made it very attractive in the rapidly growing nutraceutical markets in western countries. Recently, the FDA in the US raised concerns about the rising nutraceutical imports into the country with wide ranges of health claims and considered imposing more stringent clinical data to support the said health claims. Hence, major moringa growing countries, such as Indonesia, Malaysia and Thailand are funding scientific studies of moringa to back up the health claims, because currently moringa products has been one of the major income-earners among their agricultural exports.

Extensive research programs are conducted using the Indian and African varieties of moringa. Research has been carried out using water, aqueous methanol and ethanol extracts of freeze-dried leaves of *Moringa oleifera* and examined for radical scavenging capacities and antioxidant activities. All leaf extracts were shown to be capable of scavenging peroxy and superoxy radicals. Both methanol and ethanol extracts of moringa leaves showed the highest antioxidant activities. It has been postulated that the increasing concentration of all the extracts had significantly increased reducing power, which may in part be responsible for their antioxidant activity. The major bioactive compounds of phenolics were found to be flavonoid groups such as quercetin and kaempferol. Overall, both methanol (80%) and ethanol (70%) were found to be the best solvents for the extraction of antioxidant compounds from moringa leaves. Moringa is rich in phytosterols like stigmasterol, sitosterol and kampesterol which are precursors for hormones required for reproductive growth. These compounds increase the estrogen production, which in turn

stimulates the proliferation of the mammary gland ducts to produce milk.

Some sub-saharan African countries, treat children with moringa as remedy for malnutrition.

Murunga in Sri Lanka

In Sri Lanka, moringa cultivations are now emerging in the north and north-eastern parts of the island as a minor export crop. A number of agricultural product export companies are encouraging and promoting local farmers to grow moringa with the promise of buying their products (the current market price for raw leaves Rs 35-40/kg and dried leaf powder Rs 500-600/kg, 6-7 kg of raw leaves yield 1 kg of dried powder). At present the major emphasis is to collect the leaves and dry them into a powder for the export market. Every 45-60 days the leaves can be harvested by pruning the plant for a new crown of leaves. Large scale moringa plantations have started in some parts of the country, especially in Udawalawa and Jaffna. There are also a few organic cultivations. The price of organic products are almost six to seven times the normal product price. Even in the local markets the demand for moringa products is escalating, because of the strong immune boosting property. Moreover, the hardy drought resistant nature of the plant gives an additional incentive to the farmers who are constantly at the mercy of the scanty rainfall in the north, north-eastern parts of the island. Thus, many farmers in these areas are changing their traditional crops into growing moringa.

In traditional medicinal systems, practiced in Sri Lanka including Ayurveda, moringa leaves are used as an antidote for the recurrence of common colds and problems due to allergies. The native physicians in the country have been using many parts of the moringa plant in their medicinal preparations to treat various ailments. The natives use moringa leaves in many preparations of meat and seafood dishes believing moringa can reduce the "heaty" nature of the shell fish (probably allergies associated

with some types of shell fish). Moringa leaf preparations are also used in dressing wounds to stop bleeding.

Among the many health benefits of the constituents of the moringa plant, it is believed that drinking a tea made with moringa leaves and hot water before bed time gives a good night's rest. As a vegetable, moringa seeds are a very high source in fiber and also zinc and can regulate blood sugar helping to manage blood sugar levels. High fibre contents of the seeds are valuable to treat digestive problems and known to thwart colon cancer. Moringa is a great source of iron and has almost three times the amount of iron in spinach and in some African countries, tablets made from moringa leaves are given to treat anemic conditions. Moringa seeds provides a great supplement of calcium helping those suffering from joint pain. Interestingly, moringa helps to reverse bad cholesterol. Scientists have proved that the moringa seeds can reduce the amount of oxidized lipids in our body and help to improve cardiac health.

Moringa has lot of minerals that are essential for growth and development among which calcium is considered as one of the important minerals for human growth. While 8 ounces of milk can provide 300-400 mg, powdered moringa leaves can provide more than 4000 mgs.

As mentioned, moringa leaves are found to be a powerhouse of natural antioxidants due to their marked antioxidant activity even surpassing that of Vitamin C. Moringa seeds contain almost 30 antioxidants it contains vitamins A, B-complex, C and other free radical busters that save body from severe oxidative damage.

Moringa seeds can be preserved for long time without loss of nutrients. Seeds are packed with antioxidant, anti-inflammatory and antiseptic properties and are very beneficial for skincare lotions. The oil obtained from moringa seeds is used as a moisturizer or used to treat skin problems like skin rashes and sunburn.

Nutrients	Fresh leaves	Dry leaves	Leaf powder	Seed	Pods
Calories (cal)	92	329	205	–	26
Protein (g)	6.7	29.4	27.1	35.97 ± 0.19	2.5
Fat (g)	1.7	5.2	2.3	38.67 ± 0.03	0.1
Carbohydrate (g)	12.5	41.2	38.2	8.67 ± 0.12	3.7
Fibre (g)	0.9	12.5	19.2	2.87 ± 0.03	4.8
Vitamin B1 (mg)	0.06	2.02	2.64	0.05	0.05
Vitamin B2 (mg)	0.05	21.3	20.5	0.06	0.07
Vitamin B3 (mg)	0.8	7.6	8.2	0.2	0.2
Vitamin C (mg)	220	15.8	17.3	4.5 ± 0.17	120
Vitamin E (mg)	448	10.8	113	751.67 ± 4.41	–
Calcium (mg)	440	2185	2003	45	30
Magnesium (mg)	42	448	368	635 ± 8.66	24
Phosphorus (mg)	70	252	204	75	110
Potassium (mg)	259	1236	1324	–	259
Copper (mg)	0.07	0.49	0.57	5.20 ± 0.15	3.1
Iron (mg)	0.85	25.6	28.2	–	5.3
Sulphur (mg)	–	–	870	0.05	137

*The nutrient compositions of leaves, leaf powder, seeds and pods.
(All values are in 100 g per plant material)*

Water purification

Additionally, the water purification ability of the seeds have now been recognized among those living in both rural and urban areas, and moringa seeds are often added into wells

to clarify water. During the early days native travellers carried moringa seeds to purify the water along their travels. Recently, water filters with moringa seed powder are used to clean water and remove hardness in the CKD (chronic kidney disease) effected North and North eastern

regions of Sri Lanka. Several NGOs are now investing in making low cost water filters with powdered moringa seed powder to use in the affected areas.

Moringa oleifera seed suspension for the softening of hardwater are being tested in many laboratories. The mechanism for softening was found to be due to adsorption with the adsorption isotherm approximating to the Langmuir type, and conversion of soluble hardness-causing ions to insoluble products by precipitation reactions. Removal efficiency was found to increase with increasing dosage of *Moringa oleifera*. Conveniently, hardness removal was found to be independent of pH of the raw water.

Future

Moringa samples from different environments have shown differences in its nutrient content and other beneficial effects. Research on locally grown *Moringa oleifera* is yet to gain importance in Sri Lanka. More studies are need to corroborate the research findings in the published literature. Sri Lanka with her optimum environment conditions for the growth of moringa plants, moringa cultivation can become a great source of income for the nation. Unlike many traditional crops, moringa can withstand harsh weather conditions making it more sustainable for our island nation. Also, there is huge potential in value addition to moringa products promising higher income to the farmers and to the country.

(see also Link Natural Digest Vo. 5 , No.1)

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Moringa oleifera Flowers



Moringa oleifera ready to be prepared as a curry



Moringa oleifera leaf powder

STUDY OF THE VOLATILE CONSTITUENTS OF THE ESSENTIAL OIL AND ABSOLUTE OF NYMPHAEA NOUCHALI

By Jayodhya Amarasinghe* and Lakshmi. Arambewela*

Nymphaea nouchali a beautiful aquatic plant which is also known by the synonym *Nymphaea stellata* has much medicinal, cultural and religious importance. *Nymphaea nouchali* was the national flower of Sri Lanka and also of Bangladesh. Recently this was found to be an introduced plant and endemic Sky blue manel has been declared the national flower of Sri Lanka. This deals with a study of *N. nouchali* grown in Sri Lanka and comparison with Sky blue manel and other related species. The essential oil of *N. nouchali* flowers was obtained by water distillation using the Clevenger's apparatus and the flowers were subjected to the GC-MS analysis. The major compound in *N. nouchali* essential oil was found to be 6,9-Heptadecadiene and Heptacosane in the absolute.

Keywords: *Nymphaea nouchali*, essential oil composition, absolute, heptadecadien

Introduction

The genus *Nymphaea* of family *Nymphaeaceae* has two species in Sri Lanka.

N. nouchali, the well-known Nil manel and *N. pubescens* which is commonly known as Et-olu or Olu. Apart from these two species another plant called Tel-olu or Beheth olu exists. This flower is a well-known herb among traditional physicians for treatments of diseases.

N. nouchali is known as red and blue water lily, blue water lily, and star lotus in English. *N. nouchali* is also referred as *N. stellata* which belongs to genus *Nymphaea* and family *Nymphaeaceae*. When this star shaped beauty is seen in a lake in abundance, the leaves and flowers give the appearance of a sky filled with stars. According to Greek mythology Nymphs were supernatural feminine beings associated with spring. Flowers of *N. nouchali* is often called as nilothpalam, alli thamarai and by many other names in different countries.

There is a controversy developing that the Sky blue Manel flower is the native *N. nouchali* and not the purple flower. Several researchers are trying to identify the correct flower and recently the Sky blue Manel flower was declared the national flower of Sri Lanka.

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Nil Manel

Sri Lanka's varied climates and topography has resulted in a very rich biodiversity¹. Water lilies have been popular as an ornamental flower that produces striking flowers throughout the year. *N. nouchali* grows in the dry zone especially in shallow streams, tanks, ponds and in natural wetlands. This beautiful water lily is native to the Indian subcontinent which includes Philippines, Sri Lanka, Myanmar, Afghanistan, Pakistan, Bangladesh, Nepal and also reported in Africa and Australia.

This sweet fragrant flower is violet in colour and is bisexual¹. The flower has 16-30 stamens which are bright yellow. *N. nouchali* has 25-27 petals with a lanceolate shape which opens from sunrise to early afternoon. The sepals control the closing and the opening mechanism of the flower. Once the sepals are removed the flower can no longer proceed with this opening and closing mechanism. A fully grown and open flower is 15-20cm in diameter and appears almost constantly from September to February.

N. nouchali is historically important for a long time not only in Sri Lanka but also in other countries too. The Egyptian history brings many records of the existence of this flower when examining the tombs where the Pharaohs were

buried. Pharaohs were buried with the flowers and paintings of it. Also, it was found that the Pharaohs have cultivated this flower in the palace garden. The famous Sigiriya fortress carries some interesting information about the ancient city which was built by king Kashyapa. The lady on the left hand side of the World famous Sigiriya frescoes the apsaras is holding a nil manel flower.

Whole *N. nouchali* plant is used in Siddha and Ayurvedic medicine². The flowers are mainly used for religious events. The rhizomes, fruits, leaves, petioles, roots, flowers, tubers and seeds are used as edible parts in different ways. Flowers and the stalks are used as vegetables, green manure and fodder. Due to the sweet and the unique fragrance of the flower the essential oil is used in the perfumery industry. The plant possesses a bitter flavour and is one of traditionally recommended antidotes for various ailments³. In Ayurvedic medicine, particularly high fever and pitta conditions³.

The present study deals with the investigations of the volatile constituents of the essential oil and absolute of *N. nouchali* (Nil Manel) and comparison of absolutes with Sky blue Manel flower and Tel olu.

Violet flowered *Nymphaea* species (Nil manel)



Nil manel flower



Tel olu



Tel olu



Sky blue Manel

Methodology

Plant materials

Nymphaea nouchali flowers with the petioles were purchased in the morning from Pillawa, Nugegoda, in Sri Lanka. The flowers were identified at the Herbarium of Royal Botanical Gardens, Peradeniya, Sri Lanka.

Distillation of the essential oil

The flowers after removing the petioles were weighed, cut and placed in a round bottom flask and the Clevenger apparatus was fixed. The distillation arm contained a layer of diethyl ether and n-pentane (1:1) and the distillation was carried out for 5 hours continuously. The organic layer was collected and dried using anhydrous sodium sulphate. The essential oil containing organic solvent was placed on a test tube and the organic solvents were evaporated. The yield of the essential oil was 0.023%

Preparation of the absolute

The flowers were cut into small pieces and soaked in n-hexane overnight to extract the compounds to the hexane layer. The extract was filtered, and hexane was evaporated to obtain the concrete. To the concrete, ethanol was added and the ethanolic extract was kept in the deep freezer overnight. After the waxes separated, the solvent was filtered. Ethanol was evaporated using the rotary evaporator and the absolute was obtained. The absolutes of two other *Nymphaea* species found in Sri Lanka namely Tel olu and Sky blue manel were also prepared in the same manner.

Thin Layer chromatography of the absolutes

The absolute of *N. nouchali* was spotted on TLC plates together with the absolutes of two other *Nymphaea* species found in Sri Lanka namely Tel olu and Sky blue manel. The plates were developed in Toluene: Ethyl acetate (7:3) solvent system After chromatography the TLC plate was dried, observed under UV light and sprayed using vanillin sulphate-sulphuric acid spray reagent for the visibility of the spots.

Analysis of the essential oil and the absolute using Gas Chromatography-Mass Spectrometry (GC-MS)

GC-MS analysis was performed on Agilent 5973 instrument using a column (30 m×0.25 mm i.d., 0.25 µm film thickness) coated with (5%-Phenyl)-methylpolysiloxane and coupled with a 5973 Network Mass Selective detector (Agilent). Chromatographic conditions: He, flow: 0.9 ml/min. Injection temperature: 2500C. Injection volume: 1.0 µl. Injection mode: split (1:100). Temperature program: initial 50°C (held for 1 minute), ramp to 210 °C at 40C/min(held for 1 minute), Compounds were identified using Wiley database.

Results and Discussion

The hydro-distillation of the flowers of *N. arbortritis* yielded 0.02 % (w/w, wet basis) of fragrant essential oil.. The yield of the concrete was 0.137%. The Thin layer chromatogram of the three absolutes after spraying is given below

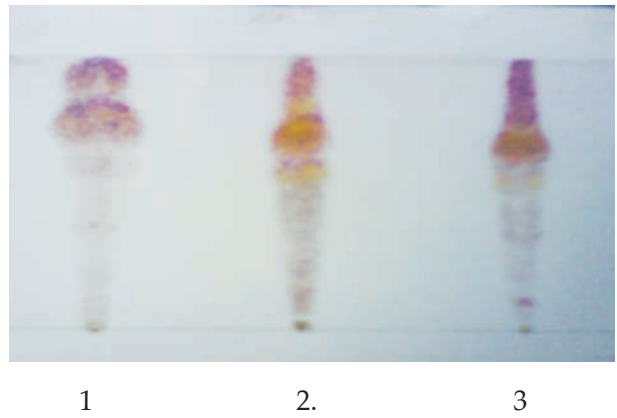


Fig 1 Thin layer chromatogram of the absolutes of three manel species after spraying Spot 1 - Tel olu absolute, Spot 2 - *Nymphaea nouchali* absolute Spot 3 – Sky blue manel absolute

After you find out all the things that can go wrong, your life becomes less about living and more about waiting
 - Chuck Palahniuk, Choke

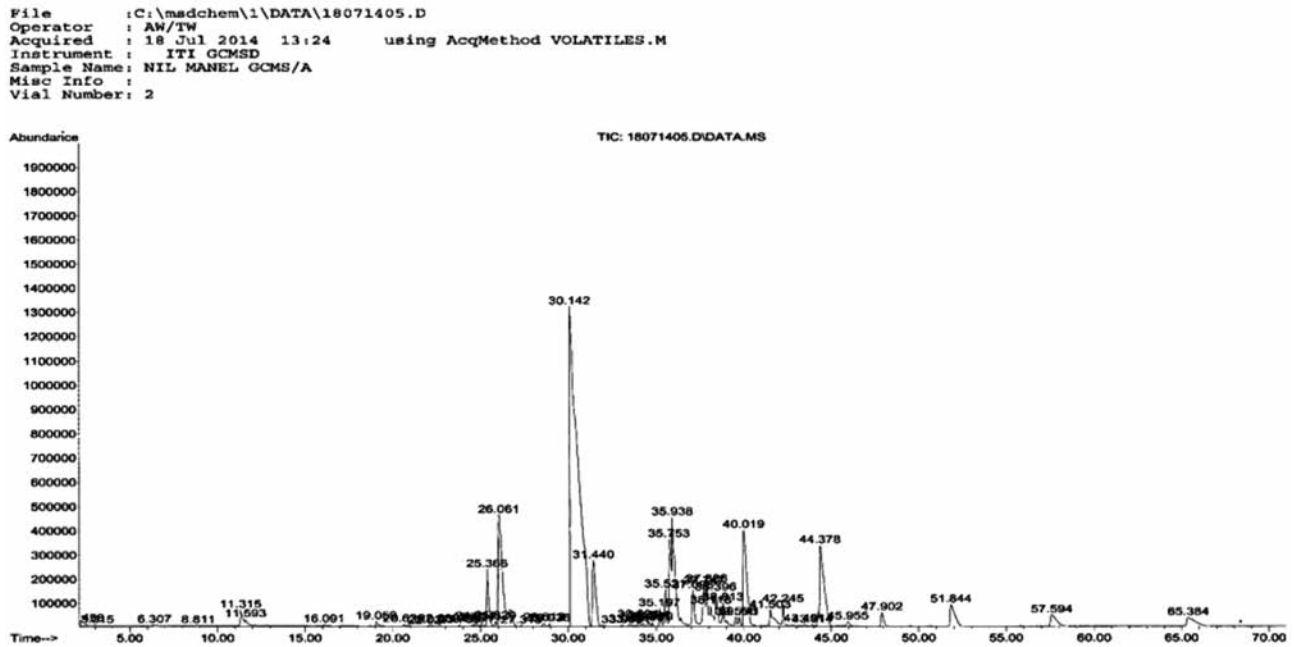


Fig. 2 Gas chromatogram of *Nymphaea nouchali* essential oil

Retention time	Peak area%	Compound	Retention time	Peak area%	Compound
11.315	0.74	Benzenemethanol	38.396	1.12	1-Nonaecanol
19.059	0.19	Cinnamaldehyde	39.555	0.25	2,6,10,14-Hexadecatetraen-1-ol,3,7,11,15-tetramethyl-,acetate,(E,E,E)-
24.717	0.14	alpha.-Ionone	39.741	0.23	Kaur-16-ene
25.366	2.12	1,6,10-Dodecatriene	40.019	6.57	Heneicosane
25.829	0.13	Cyclopentane	41.503	1.24	9,12-Octadecadienoic acid
26.061	8.75	Pentadecane	42.245	0.54	Docosane
26.664	1.31	alpha.-Farnesene	44.378	7.14	Tricosane
28.612	0.13	9,12-Octadecadienoic acid	45.955	0.25	1,6,10,14-Hexadecatetraen-3-ol,3,7,15-tetrmethyl-,(E,E)-
30.142	48.91	6,9-Heptadecadiene	47.902	0.69	Octacosane
31.440	4.05	Heptadecane	51.844	1.95	Pentacosane
33.481	0.12	Tetradecanoic acid	57.594	1.31	Docosane
35.197	0.43	Neophytadiene	65.384	1.41	Octacosane
35.521	0.79	z-5-Nonadecene			
35.753	3.76	Nonadecane			
37.098	1.71	Trans-beta.-Farnesene			
37.747	1.83	n-Hexadecanoic acid			

Table 1. GC- MS results for the Nil manel essential oil

File :C:\msdchem\1\DATA\18071408.D
 Operator : AW/TW
 Acquired : 18 Jul 2014 17:18 using AcqMethod VOLATILES.M
 Instrument : ITI GCMSD
 Sample Name : NIL MANEL ABSOLUTE/A
 Misc Info :
 Vial Number: 3

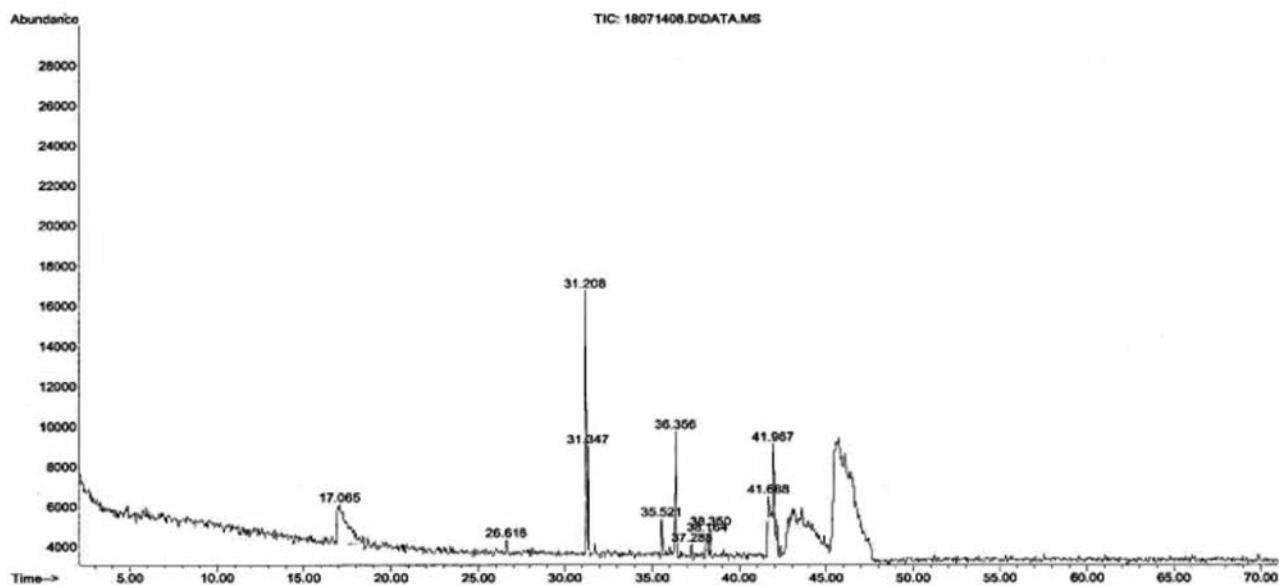


Fig. 3 Gas chromatogram of *Nymphaea nouchali* absolute

Retention time	Peak area%	Compound
17.065	14.40	Benzoic acid
31.208	14.07	6,8-Heptadecadiene
35.521	2.16	Chloroacetic acid
36.356	5.54	2-pentadecanone
41.688	6.49	9,12-Octadecadienoic acid
41.967	5.01	Hexadecadienoic acid
43.033	8.52	Nonahexacontanoic acid
45.723	37.00	Heptacosane

Table 2.
GC MS results for the Nil manel absolute

Results & Discussion

The major compound in *N. nouchali* essential oil is 6,9-Heptadecadiene. 1,6,10-Dodecatriene, Pentadecane, Heptadecadiene, Heptadecane, Nonadecane, Beta-farnesene, Heneicosane and Tricosane are the other main compounds present in the essential oil.

The absolute also contained a semiochemical named Heptadecadiene which is also a pheromone. 2-Pentadecanone is a well-known flavour and fragrance agent that was also found in the *N. nouchali* absolute. An essential fatty acid known as 9,12-Octadecadienoic acid also known as linoleic acid was discovered in the absolute.

The TLC chromatogram indicates the volatile and non-volatile compounds present in the three absolutes. Several compounds having same Rf values are present in Tel olu, *N. nouchali* and Sky blue manel absolutes. Therefore, detail studies of Sky blue manel and Tel olu are required for comparison with *N. nouchali*.

Acknowledgements

The authors gratefully acknowledge the facilities and financial assistance provided by the College of Chemical Sciences to carry out this work.

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“Plants are our food, oxygen, and medicine. Some even say they are one of the most pleasurable experiences on earth! From the flowers to the trees and the seas filled with coral dreams; the earth’s natural flora has inspired and enhanced humans for as long as time can tell. That’s why the power of plants is the key to unlocking our enjoyment of life.”

- Natasha Potter

WLADYSLAW S. BRUD - AN ICON OF THE FRAGRANCE INDUSTRY HAILING FROM POLAND

By R.O.B. Wijesekera



Dr. Wladyslaw Brud was a successful technocrat in the Fragrance Industry of Poland before he established his connections with the international scenario. He was a renowned expert in this domain when the author first came to know of him and his experience with the Polish Fragrance Company Pollena Aroma. This was when the author was working for UNIDO in the decade of the 1970's. The author was privileged to count him as one of the experts associated with the projects within his group namely the chemical industry. Soon Dr Brud became a familiar figure within the UNIDO Chemical Industries group at Vienna, as he was recognized as one of the successful experts in terms of his knowledge as well as his method of knowledge delivery.

Maybe that this fact influenced the author to propose that he spent a stint mentoring scientific colleagues at the CISIR, the institute in Colombo at which the author spent a ten year period prior to assuming his role with UNIDO.

Several CISIR scientist were trained by Dr. Brud both at Colombo and in Pollena-Aroma in Poland and the effective training given by Brud was well recognized.

Dr. Brud was a researcher in Poland and was also a lecturer in perfumery at the Warsaw Technical University and was founder and member of the Board of the Polish Society of Cosmetic Chemists. He was also a member of the Polish Standardization Committee Council and also active in the business community dealing with essential oils . International involvements include membership of the ISO TC-54 Technical Committee the Deutsche Gesellschaft fur Kosmetologia SEPAWA and the European Chemoreception Research Organization.

Finally, together with his wife, Dr Iwona Konopacka-Brud he introduced professional aromatherapy in Poland and was founder of the Polish Aromatherapy Association and remains a member of the Board.

Dr. Brud was the author of an impressive number of publications and patents in the area of essential oils flavors.

He was Chair of the IFEAT Executive Committee from 1986-89 and IFEAT President from 1994-2000. He has been with IFEAT since its formation in Kyoto in 1977 and has been an active contributor to the field of essential oils and perfumery.

PRODUCTS FROM LINK NATURAL

LINK KESHA HERBAL HAIR OIL – RELAUNCH

By Anya Dalpadado

In 1997 Link Natural introduced the first ever branded hair oil, “Link Kesha” to the Sri Lankan market. Link Kesha is a unique and efficacious nourishing herbal hair oil which helps to make the hair beautiful and healthy, externally and internally.

Reaching out to today’s modern woman, Link Kesha re-launched its herbal hair oil range with a brand- new look and feel in October 2019. The main changes to the brand was brought out through redesigning the packaging and introducing a new variant. The changes were

brought about to the brand post conducting several focus groups studies across the country. The study revealed that most consumers found the existing bottle and outer carton of Kesha to be outdated. Thus, the bottle shape and outer carton design was changed to be more modern and progressive. Further, in order to emphasize the key ingredients in Kesha, images of every ingredient were added on the side of the pack. As a key differentiator to segregate each variant, different tones of green were used for every variant.



Link Kesha herbal hair oil range with a brand- new look

Further, a new variant “Kesha Lite” was introduced as a non-sticky, light and smooth oil helping the brand to be relevant to the busy and dynamic youth target group. This oil could be easily applied before going out- doors as it is very light in texture. This new variant of oil not only helps girls maintain their hair but also gives them the nourishment they require for their hair.



Link Kesha – Lite (50 mL)

In order to reach a larger audience and help allow customers to experience the goodness of the hair oil, Link Kesha hair oil was introduced in a trial pack size of 50 mL along with the Re-launch.

The consumer focus group study further revealed that the first ever commercial on Kesha had a very high recall amongst the target audience. Therefore, the old TV commercial was revamped with a new model and various scenarios to suit the everyday life- style of the modern girl, whilst retaining the key melody of the initial TV Commercial for high top of mind recall. The Re-launch will be further supported via a PR, Press and Digital campaign.

Link Kesha is specially formulated by combining the wisdom of Ayurveda and modern science. It contains 8 natural herbal extracts which are time tested and proven to deliver a certain benefit, along with natural vitamin E and coconut oil for nourishment. The hair oil provides

several benefits with daily use, such as reducing hair fall, preventing premature greying and also split ends and controlling dandruff. It also provides additional internal benefits, such as reducing headaches and enhancing eyesight with continuous use. Overall Link Kesha provides a voluminous and lustrous head of hair to women.



Mrs. Anya Dalpadado Category Manager - Personal Care



Mr. Nishantha Paranagama - Sales Director



*Research & Development Scientist
Ms. Ranji Kankanamge*



Part of the audience

"LINKING" WITH PEOPLE AND SOCIETY

"SAMAHAN SAHANA SATHKARAYA" AT KANDY PERAHERA

Buddika Doranegama and Samagi Rajapakshe

Kandy Esala perahera is one of the most famous religious festivals in Sri Lanka which is organized by the Temple of the Tooth Relic in Kandy. Annually, this religious festival is held in the months of July and August. The streets are flooded with local pilgrims and foreigners to witness this wonder which is undoubtedly the largest religious festival in the country.

This perahera consists of many traditional and local dances such as fire dance, whip dance, Kandyan dance and many drum dances. The presence of elephants in the procession is one of the most attractive part of the perahera.

The Kandy Perahera consists of a series of traditions. The perahera begins with the "Kap Situweema" ceremony and then the Kumbal Perahera and Randoli perahera which goes over ten nights along several Streets in Kandy town. The Perahera ends with the tradition of "Diyakapeema" Ceremony. Thousands of pilgrims line the streets of the Perahera route throughout the night to witness this magnificent sight. Consequently, the pilgrims and observers, are exposed to sunlight, dust, dew, rain in addition to experiencing a tiring time and they are at a high risk to catch cold and related symptoms like sneezing, coughing, sore throat, headache and body pains.

The company is committed and socially responsible to provide relief on these occasions and this is done through the distribution of their flagship product, Link Samahan, at special seasonal events.

Link Samahan is a clinically proven, entirely natural, safe and effective preparation for relief of cold and catarrh related symptoms. Extensive clinical trials have confirmed that regular use of Samahan helps prevent 15 common symptoms related to upper respiratory complications. It continues to dominate the market as a first choice of an instant cold remedy. Thus the initiation of the "Samahan sahan Sathkaraya" during the in Kandy Perahera.

During one Season, around 100 employees at Link Natural Products (Pvt) Ltd actively participate in this event to make the program a success and all pilgrims lining the roads are provided with Samahan. A well trained and dedicated samahan team ensure the quality and safety of the preparation and distribution process, and this programme has been commended by many individuals and larger bodies.

"Samahan Sahana Sathkaraya" is being conducted for the 4th consecutive year since 2016. Around 114,905 pilgrims were provided with a

cup of samahan at this auspicious event. Rs. 2.3 million was spent by the company to complete this event and to continue this social responsibility programme.



Distributing Link Samahan herbal drink at Kandy Perahera 2019

DISTRIBUTION OF PLANTS – CREATING A WORLD OF GREEN GOODNESS

Two key medicinal plants that have dominated the ayurvedic milieu for centuries are Nelli and Rasakinda, known for their beneficial effect on health, longevity and relief from aches and discomforts. However, due to rapid urbanization and deforestation, these medicinal trees are slowly dying out like many other plants in Sri Lanka, preventing the future generations from enjoying life in a healthy green environment. Being the core ingredients of Swastha Amurtha, the 100% natural herbal drink manufactured by Link Natural Products (Pvt) Ltd., the brand has initiated a CSR project to coincide with World Environment Day, titled "Thuru Wawamu, Gatha Niwamu" (Let's plant trees to heal our bodies not just externally as well).

The aim of the campaign is to encourage the public including children, to grow Nelli and Rasakinda plants for the betterment of the environment and the well-being of all living



beings. The first phase of the programme was held at the Siyane National College, Dompe, with the participation of its principal, Anuragoda Dhammarama Thero, teachers and students, where several Nelli trees were planted within the school premises. The students were entrusted with the responsibility of looking after these plants. The event served as a means of educating the children present at the occasion about the initiation of such social causes, and the benefits of planting trees.

This was followed by another special educational session at the Sanasa Conference Hall in Palugama with volunteers from different Grama Niladhari Divisions.

A large number of Nelli and Rasakinda plants along with packs of compost were distributed on this occasion, and the participants were encouraged to plant them in their home gardens. Dr. J.T.R. Jayakody, a Senior Lecturer at the Gampaha Wickramarachchi Ayurveda Institute of the University of Kelaniya, conducted a session about the priceless benefits and medicinal values of Nelli and Rasakinda.

The implementation of this programme was supported by the Divisional Secretary of Dompe M.D.J. Prasad and its officials, Leonard Perera, The Deputy Director of Planning, Economy Development Officials, Police Officials and the members of the Youth Federation of Dompe.



Link Natural distributed Nelli & Rasakinda plants for world environment day

AVAILABILITY OF LINK PRODUCTS

Editor's Note : A frequently asked question by Link aficionados, is “where can you buy the various products from”. So for their benefit and for those who would like to sample the many superior products of Link Natural, we give below the products and their location of their availability.

	Super Market													Grocery	Pharmacy	Osusal
	Sathosa	Cargills	Keels	Arpico	Laugfs	PDK	Health guard	Family super	Air Force	City Exchange	CIC	SPAR	Odel			
Link Samahan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Link Enriched Paspanguwa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Natural Sudantha	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Kesha Hair Oil	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Hair Care Cool	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Akalpalitha	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Swastha Thriphala		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
Link Swastha Amurtha	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓
Link Five Herbs		✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
Link Gotukola Tea			✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
Link Osupen		✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓
Link Muscleguaed		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link SP Balm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Link Essentials - Siddhartha Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Pinda Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Mahanarayana Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Kendaperalumhara Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Kolaseleshma Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Sarvavisadee Oil		✓		✓			✓					✓			✓	✓
Link Essentials - Composite Pack		✓	✓	✓		✓		✓				✓			✓	✓
Link Dekatone		✓					✓					✓				✓
Link Viritone		✓					✓					✓				✓
Herbal Pharmaceutical														✓		✓

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	4.1	2	
	4.1	3	
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	7.1	16	
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		34	
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SUBJECT	VOL	from Pg	to Pg
	11.2	35	36
Earth essence Gallery	8.1	28	
	9.1	34	34
Eau de Cologne	9.2	8	14
Ecopharmacognosy	12.1	02	08
Ecosystems	13.1	17	22
Edgar Lederer, Dr.	3.2	11	12
Educational programs	8.2	32	
Employment	6.1	36	37
Endangered plants	5.1	2	4
Essential oils	2.2	30	
	3.1	20	21
	5.1	17	23
	5.1	34	35
	6.1	31	32
	7.2	14	16
	8.2	07	12
	9.2	25	32
Essential oils - Extraction	13.2	21	24
Essential oils industry	1.1	5	6
Essential oils technology	5.1	24	33
Ethics	4.1	11	13
E Tongues	10.2	35	36
<i>Eugenia caryophyllata</i> see Clove			
Expo 2012	8.1	31	
Export award	7.2	31	
Fairness cream	12.1	29	33
Fennel	6.1	26	
Fenugreek	6.1	25	
	12.2	10	14
<i>Ferula asafoetida</i> see Asafoetida			
Filaria	2.1	19	
Finn Sandberg, Prof.	2.2	9	
Flavonoides	7.2	30	
Flavors	1.1	23	24
	6.1	31	
	7.2	01	
Food	7.1	21	
Food and Nutrition	10.1	3	7
Food Packaging	15.1	08	16
Fragrance	6.1	31	32
	6.2	14	16

SUBJECT	VOL	from Pg	to Pg
	6.2	22	
	8.2	07	12
	8.2	13	15
Garcinia	6.1	27	
<i>Garcinia mangostina</i> see Mangosteen			
<i>Garcinia cambogia</i> see Goraka			
Garlic	3.2	19	22
	6.1	22	
Geoffrey Cordell, Prof.	13.1	33	34
Geranium	3.1	19	
	12.1	09	14
Ginger	Inaugural issue	18	
	6.1	19	
Gingivitis	7.2	22	
Glycerin soap see also Link Products	8.2	24	
<i>Glycyrrhiza glabra</i> see Liquorice			
Good Manufacturing Practices (GMP)	2.2	27	29
	9.1	35	36
Goraka	14 1 & 2	10	16
Gotukola tea see Herbal tea see also Link Products			
Gotukola	1.2	8	
	9.2	15	21
Govind D. Kelkar, Dr.	6.1	35	
Growth hormones	4.1	33	
Guggul tree	9.1	17	18
<i>Gyneros walla</i> see Walla patta			
Govindachari T.R, Dr.	14 1 & 2	34	35
Green Porridge of Health (Kola Kanda)	13.1	09	13
HACCP	4.1	07	10
Hair care cool see also Link products		7.2	31
Hair oils	10.1	39	
Har Gobind Khorana, Dr.	8.2	28	
<i>Harpagophytum procumbens</i> see Devil's claw			
Health	13.1	39	39
Health science	8.2	01	
Healthcare products	2.2	07	
Heen Aratta	8.2	18	22
	11.2	24	30
Heen bovitiya	4.1	04	6
Herbal cosmetics	7.1	29	
Herbal drugs	3.2	36	
	3.2	37	

SUBJECT	VOL	from Pg	to Pg
	7.1	22	27
Herbal industry	7.2	17	21
Herbal medicine	1.1	16	
	1.2	16	
	2.1	04	06
	2.1	07	08
	2.2	02	04
	3.2	33	35
	10.2	14	17
Herbal products	Inaugural issue	06	
	1.1	09	
	1.1	15	
	1.1	11	12
	1.2	13	15
	2.1	16	17
	11.1	16	18
Herbal standards	10.1	35	37
Herbal tea	1.2	8	
	5.1	5	9
Herbal therapy	3.1	14	
Herbal vines	8.1	10	14
<i>Hibiscus esculentus</i> see Bandakka			
Hildenbert Wagner, Dr	7.1	27	
Hippokrates of Kos	13.1	23	28
HIV virus	8.1	27	
Hosnu Can Baser, Prof	12.1	34	35
Hypertension	3.1	22	
<i>Hygrophila auriculata, Asteracantha longifolia</i> see Neeramulli			
IFEAT meeting	1.1	4	
Immune booster	6.1	6	9
Jak fruit	10.1	25	28
Jivaka	10.1	14	19
Karapincha see also Curry leaf	Inaugural issue	18	
	13.1	14	16
	6.1	28	
Karawila	Inaugural issue	18	
	3.1	12	14
	3.2	38	
Katuwelbatu	1.2	19	
Kendaperalumhara oil see Cramp oil, see also Link products	8.2	23	24

SUBJECT	VOL	from Pg	to Pg
Laboratory management systems	4.1	7	10
Ladies fingers see Bandakka			
Lavender	8.1	06	09
<i>Lavendula angustifolia</i> see Lavender			
Legislation	1.1	16	
Leslie Gunatilaka Prof.	2.1	17	
	11.2	31	33
Link Kesha see also Link Products	1.1	7	8
	15.2	33	34
Link Natural Products Company	Inaugural issue	1	5
	Inaugural issue	14	15
	Inaugural issue	19	22
	1.1	2	3
Link Natural Products Company Cont.	1.2	5	7
	2.1	2	3
	3.2	2	10
	4.1	19	20
	8.1	15	16
Link Products	Inaugural issue	06	
	Inaugural issue	08	
	1.1	03	06
	1.1	07	11
	1.2	08	
	2.2	05	
	3.1	04	08
	7.1	29	
	7.1	30	
	8.1	17	21
	7.1	31	
	7.2	31	
	8.2	24	
	9.1	31	32
	9.2	42	43
	9.1	39	
Link R & D Centre	15.2	02	08
Liquorice	2.1	18	
Lumbar spine disorder	6.1	10	12
Lunuwila	2.1	13	14
Mace	6.1	21	
Macro fungi	6.2	6	8
Magdolna Tetani, Dr.	3.1	05	6
Maha Narayana oil see also Link Products	11.1	28	28

SUBJECT	VOL	from Pg	to Pg
Malaria	4.1	30	32
	8.2	31	
Management	6.1	09	
	6.1	34	35
	7.2	17	21
Mangosteen	2.2	30	
	11.2	10	15
<i>Manilkara sapota</i> see Sapodilla			
Maphraokathi see Dikiri pol			
Marico	15.1	28	30
Marketing	1.1	10	11
Markets	2.2	7	
	7.2	1	
Marthanda Valiathan, Prof.	10.1	38	
Massage therapy	3.1	7	11
Materia medica	10.1	8	13
<i>Matricaria reticulata</i> see Chamomile			
Medicinal plants	1.1	19	
	5.1	36	38
	6.1	30	
Mental disorders	3.2	33	35
Milk Thistle	Inaugural issue	18	
	9.1	18	18
Mistletoe	6.1	33	
<i>Momordica charantia</i> see Karawila			
<i>Morinda citrifolia</i>	9.2	39	41
<i>Moringa oleifera</i> see Drumsticks			
Mosquito repellents	9.1	31	32
	9.1	33	33
Mukuna pruriens	9.1	18	19
<i>Murraya koenigii</i> see Karapincha			
Muscle cramps	8.2	23	24
Musclegard see also Link Products	7.1	31	
Mushrooms	6.2	6	8
Marigold	13.2	07	10
Natural Product Research	15.2	14	20
Natural products	7.2	30	
Natural fragrances	10.1	20	24
Neem	2.1	19	
	15.1	21	25
<i>Nepenthes distillatoria</i> see Pitcher plants			
Neeramulli	12.2	20	25

SUBJECT	VOL	from Pg	to Pg
New products	6.1	1	
Nitya Anand	5.1	14	
Noni Juice	9.2	39	41
Nutmeg	6.1	21	
Nutraceuticals	12.2	07	09
	12.2	29	31
Natural products	14 1 & 2	07	09
Nephroprotective agents	15.1	17	20
Norman R. Fransworth, Prof.	8.1	25	26
	4.1	27	28
<i>Nymphaea nouchali</i>	15.2	26	31
Odour	4.1	36	
Okra see Bandakka	2.1	18	
Oleoresins	8.2	16	17
Onions	2.1	11	12
Operations management	4.1	19	20
Oral health	7.2	22	
Origin of life	7.1	26	
Ornamental plants	4.1	25	26
<i>Osbeckia octandria</i> see Heen bovitiya			
Panchakarma	6.1	2	5
Papaya	4.1	29	
	9.1	2	
Paracelsus	3.1	6	
Paspanguwa see also Link products	3.1	4	
Patents	3.2	36	
<i>Pelargonium graveolens</i> see Geranium			
Pepper	2.2	20	24
	6.1	20	
	7.1	28	
Pepper Rose	4.1	25	26
Peppermint	4.1	32	33
Perfumes	6.2	14	16
Perfumery	11.2	02	09
Pest Management	9.2	25	32
Peter Tetenyi, Prof.	3.1	5	6
Pharmaceutical industry	4.1	11	13
Phenolic compounds	7.2	30	
<i>Phoradendron flavescens</i> see Mistletoe			
Phytopharmaceuticals	8.2	18	22
Phytotherapy	Inaugural issue	16	
Pine	1.2	37	37

SUBJECT	VOL	from Pg	to Pg
<i>Piper betle</i> see Betel			
<i>Piper longum</i> see Tippili			
<i>Piper nigrum</i> see Pepper			
Pitcher plants	8.2	30	31
	9.1	10	14
Plant medicine see Herbal medicine			
Plants	9.2	46	47
Plants powered healthcare	14.1 & 2	02	06
Plumeria	11.1	19	22
Polpala	1.2	19	
Polyphenols	10.1	29	34
Pomegranate	3.2	35	
	7.1	2	6
Processing technology	1.1	9	
	1.2	11	12
	1.2	17	18
Procurement	7.2	17	21
Product development	Inaugural issue	15	16
	5.1		
	2.3		
Propolis	Inaugural issue	13	
<i>Pterocarpus santalinus</i> see Red sandalwood			
Pumpkin see Wattakka			
<i>Punica granatum</i> see Pomegranate			
Quality control	2.2	31	
	3.1	2	3
Quinghasu	11.2	16	20
Quinine	12.1	15	23
Rain forests	2.1	9	10
	5.1	11	13
	6.2	20	
Rasakinda Inaugural issue	1.8		
	6.1	06	09
	9.1	17	17
Rasayanas	5.1	5	9
<i>Rauwolfia serpentina</i>	9.1	15	16
Raw materials	6.1	31	32
	7.2	17	21
Red Sandalwood	2.2	31	
Research Inaugural issue	1.7		
	7.1	24	
Research Personnel	8.1	24	

SUBJECT	VOL	from Pg	to Pg
Richard Evans, Schultes Dr.	12.2	26	27
Robert E. Sroboda, Dr.	8.2	27	
R.O.B. Wijesekera, Dr.	1.2	05	7
Rose oil	4.1	21	24
Royal jelly	8.2	06	
<i>Ruellia tuberosa</i>	14 1 & 2	30	33
Rural poverty	6.2	12	
Saffron	8.2	13	15
Sales training	8.1	30	
Samahan see also Link Products	Inaugural issue	9	12
	1.2	03	04
	6.2	24	
	8.1	22	23
Samahan balm see also Link Products	7.1	31	
Sandalwood	8.2	02	06
	15.1	02	07
<i>Santalum album</i> Linn. see Sandalwood			
Sapodilla	8.1	02	05
<i>Sarracenia purpurea</i>	8.2	30	31
Sarvavisadee oil	12.1	36	36
Scavenging activity	7.2	30	
Scents	6.2	14	16
<i>Schinustere bunthifolius</i> see Pepper rose			
Scientific meetings	1.1	4	
Scientists	1.2	10	
	3.1	06	
Seasoning agents	8.2	13	15
Secondary metabolites	6.2	2	5
Shilajit	7.1	12	15
Silybum marinum see Milk Thistle			
Shulahara see also Link Products	10.1	33	34
Six oils see also Link Products	11.2	34	34
SLIDA Training	7.2	32	
SLS certification	6.2	23	
Smoking	3.2	32	
	7.1	11	
Society	4.1	11	13
<i>Solanum virginianum</i> see Katuwelbatu			
<i>Solanum trilobatum</i>	2.2	32	
<i>Solanum xanthocarpum</i>	2.2	32	
Soursop	6.2	9	12
SP Balm see also Link Products	12.2	28	28

SUBJECT	VOL	from Pg	to Pg
Spa treatment	9.1	34	34
Spice oleoresins	13.2	02	06
Spices	1.2	13	
	6.1	16	29
Sponges	15.2	09	13
Standardization	2.2	31	
Standards	10.1	35	37
Stereochemistry	4.1	34	35
Stevia	5.1	39	41
<i>Stevia rebaudiana</i> see Stevia			
Sudantha see also Link Products	6.2	23	
	7.2	22	
	7.2	32	
	7.2	32	
	11.2	39	39
Sugar and health	12.1	37	38
Sunscreen product	9.1	25	29
Sushrutha	9.2	2	7
Swastha – Amurtha see also Link Products	14 1 & 2	36	36
Swastha Thriphala see also Link Products	2.2	05	06
Sweeteners	5.1	39	41
	5.1	42	
Tamarind	3.2	12	
	6.1	27	
<i>Tamarindus indica</i> see Tamarind			
Tannins	10.1	29	34
Tea	5.1	05	09
Tea bags	4.1	38	
Thebu	12.1	24	28
Therapeutics	6.2	01	
Thippili	1.2	20	
	10.2	11	13
<i>Tinospora cordifolia</i> see Rasakinda			
Tissue culture	1.2	13	15
	6.2	02	05
Tomato	3.1	22	
Trade fair Jaffna	11.1	30	31
Traditional knowledge	7.2	13	
Traditional medicine	Inaugural issue		08
Trans fat ban	11.2	38	38
<i>Trichosanthes cucumerina</i>	9.2	35	38
Tropical plants	7.2	30	

SUBJECT	VOL	from Pg	to Pg
Turmeric	6.1	19	
	7.2	07	13
	9.1	16	17
Vanilla	3.1	15	18
	4.1	37	
	7.1	07	11
<i>Vanilla planifolia</i> see Vanilla			
Vetiver	3.2	38	
<i>Vetiver zizanioides</i> see Vetiver			
Viagra	1.1	18	
Violet tree	1.1	18	
Viral Hepatitis	4.1	04	06
<i>Viscum album</i> see Mistletoe			
Walla patta	9.1	21	24
Water hyacinth	1.2	25	
Water hyssop see Lunuwila			
Wattakka	3.2	37	38
Wellness	7.1	01	
Wenivel	5.1	15	16
WHO guidelines	2.1	07	08
Wild plants	5.1	36	38
Willow Bark	13.1	03	08
Wines	1.1	20	
	1.2	25	
	7.1	11	
	7.1	28	
	9.2	33	34
<i>Withania somnifera</i> see Ashwagandha	11.1	29	29
Wladek S. Brud, Dr.	13.2	32	
	15.2	32	
Xiao Peigen	6.1	30	
Yakwanassa	2.1	14	15
Ylang ylang	11.1	10	15
<i>Zingiber officinale</i> see Ginger			

BOOK REVIEW

MANAGING RESEARCH, DEVELOPMENT AND INNOVATION: MANAGING THE UNMANAGEABLE 3RD EDITION

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Ravi Jain,
Harry C. Triandis,
Cynthia W. Weick

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Response

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- Alan Wilson Watts,
The Essential Alan Watts

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Thanking you.

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Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you, and the storms their energy, while cares will drop off like autumn leaves. As age comes on, one source of enjoyment after another is closed, but Nature's sources never fail.

- John Muir

NOTE TO POTENTIAL CONTRIBUTORS

Link Natural Digest

The DIGEST is a popular publication, albeit a scientific one, dedicated to medicinal plants, herbal healthcare and personal care products, essential oils, aromatherapy, herbal therapy and Ayurveda, and related healthcare systems. It is published bi-annually.

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**The Digest Mail Bag
Welcomes Reader's
Views & Ideas.**

