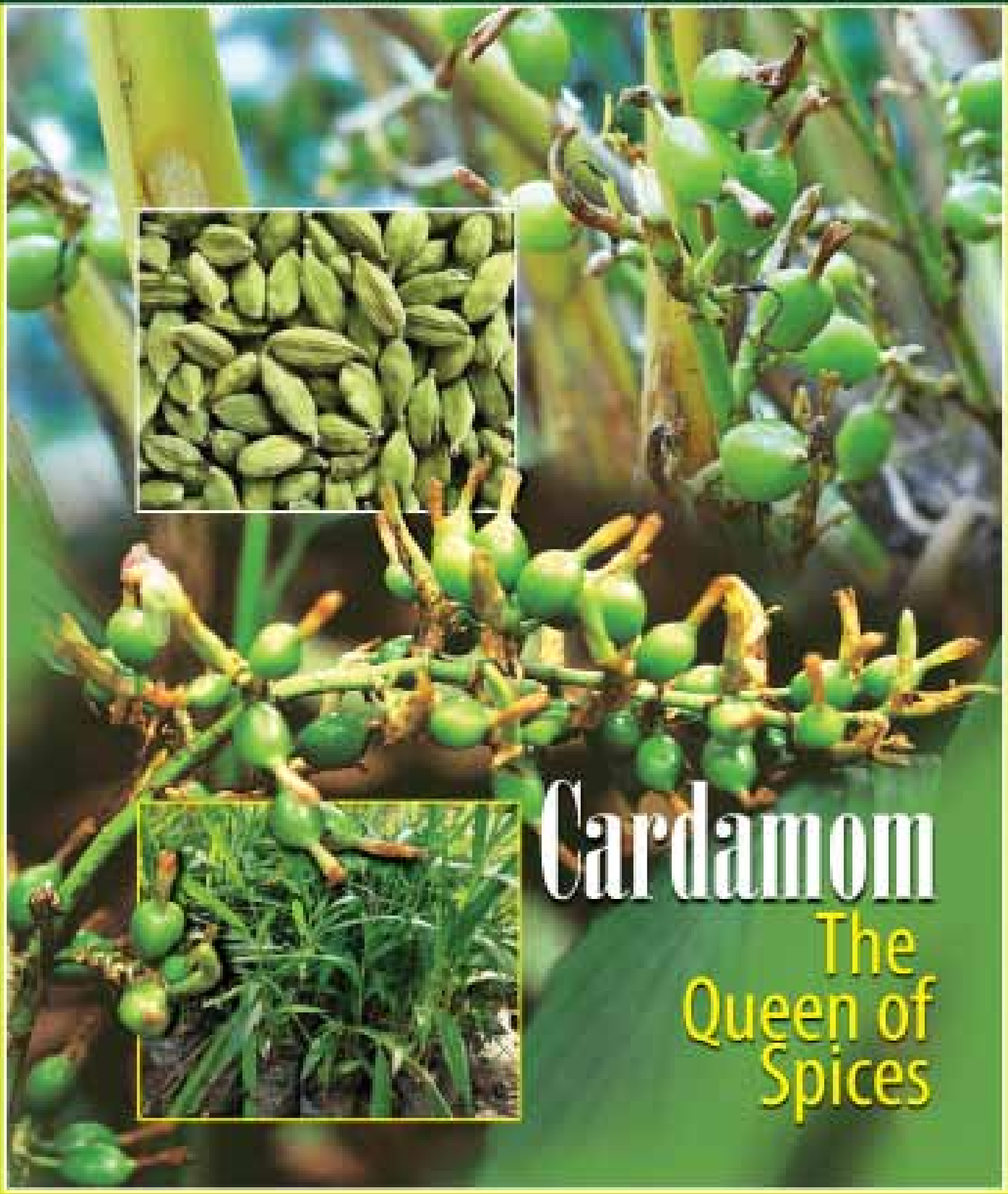
Link Natural

DIGEST

Volume.17, Issue 1 , 2021

LINK NATURAL PRODUCTS (PVT) LTD



Cardamom

The Queen of Spices

Link Natural DIGEST

Volume 17, Issue 1, 2021 ISSN : 1391-8869

IN THE PAGES THAT FOLLOW.....

Registered Office
C. I. C. House,
199, Kew Road,
Colombo 02, Sri Lanka.

Factory & Office
Malinda, Kapugoda,
Sri Lanka.

Tel.: +94 11 2409294
Fax: +94 11 2409293

e.mail :
info@linknaturalproducts.com

web :
www.linknaturalproducts.com

EDITORIAL

The latest documentary "Extinction" produced by none other than Sir David Attenborough will indeed strike a chord to Sri Lankans who are presently being inundated with news of deforestation and devastation of the environment in various ways. The film claims that little is left of the wild, as natural habitats are being squeezed between aggressive agriculture and urban sprawl. According to him extinction and loss of biodiversity is so much more than the loss of animals, but it is an effect on an entire system.

The film goes on to explain the impacts of biodiversity loss on our soil functioning, starting with breaking down leaf litter by underground organisms, role of insects pollinating our crops, and how losing trees and wetlands can contribute to landslides and floods. While this is only to be expected, more alarming is the potential link which he lays bare between these drivers of biodiversity loss and emerging diseases. While not intending to be the voice of doom, this includes the pandemic situations of today. The rationale behind it is that the wildlife trade brings thousands of stressed animals into close contact, providing the ideal opportunity for viruses to jump between species. Simultaneously, removing these large predators results in increased numbers of rodents and bats which are more likely to carry dangerous viruses. According to Peter Daszak of Ecohealth Alliance "We've been changing biodiversity in critical ways which made the pandemic more likely to happen".

It is thus obvious that biodiversity loss is blatantly happening, and also so obviously a bad thing for the future of humanity. Why then have we failed to act and what needs to be done?

Altogether, ideas expressed in this film are radical and sets you thinking beyond the box. It is explicitly calling for major changes in the way our economies work with a greater focus on both planetary boundaries and global inequality.

Scientists have recently demonstrated what would be needed to bend the curve on biodiversity loss. As Attenborough says in the final scene, "What happens next, is up to every one of us".

Dilmani Warnasuriya

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

GREEN GOLD FOR HUMAN WELFARE

*By Lakshmi Arambewela**

The " Green Gold " – the Leaves of Life - are power houses, the great driving force for Life on Earth and chlorophyll is the molecule of life. Without it the life as we know it, would not exist. Plants are sources of food, vitamins, minerals, essential fatty acids, proteins, fibre etc. In addition, they are excellent sources of medicine.

In the last part of the 20th century a return to "Nature" was witnessed in matters related to food, medicine and associated industrial ventures, which led to the emergence of a brand of technologies called Herbal Technology.

Herbal technology refers to technologies used for the manufacture of value-added plant products such as herbal drugs and pharmaceuticals, functional foods, health foods, health drinks, nutraceuticals, cosmeceuticals, biopesticides, biocontrol agents etc.

Why drugs from plants ?

Drugs from plants are needed for primary health care needs of the people especially in developing countries. Further, no suitable drugs are available for some diseases, immune stimulants etc. In addition, the drugs from plants are believed to be less toxic than synthetic drugs. Further, plant-based industries are generally environmentally friendly and renewable sources of raw materials are available.

Disadvantages of modern drugs

Modern drugs have many disadvantages. They can produce serious side effects. It is believed that Iatrogenic diseases are the fourth leading cause of death in USA and other nations (JAMA, April 1998). Side effects of drugs kill more Americans annually than World War II and Vietnam war combined (M. Rath N. Y. Times 28.2.2003). Around 2600 persons have died in the Twin Tower tragedy on 11th September 2001. It was recognized that about the same number die in USA from side effects of prescription drugs every 10 days (JAMA, April 1998). Therefore, at present there is a trend is to go for more herbal drugs.

** Dr. Lakshmi Arambewela has been a prolific and renowned researcher in the field of medicinal plants for over 35 years while she was in the Natural Products Section of the CISIR/ITI and guided young researchers both at the Institute and the Institute of Chemistry where she was a Past President and played a leading role in the academic and research field conducting lectures and supervising the research projects of ICHEM undergraduates.*

Trade in Medicinal & Aromatic plants

According to World Health Organization (WHO), 60% of the world's population relies on herbal medicine and about 80% of the population in developing countries depends almost totally on it for their primary health care needs. The Global Herbal Medicinal Products Market accounted to USD 9.21 billion in 2018 to a projected value of USD 17.7 billion by 2026.

The world demand for medicinal plants at present is estimated to be about USD 500 billion This is expected to reach 5 trillion USD in 2050. A large number of medicinal plants are used commercially in W. Europe, and Germany, is one of the main importers of medicinal plants and also a major international producer and exporter of medicines. A full 40 percent of the drugs behind the pharmacist's counter in the Western world are derived from plants that people have used for centuries, including the top 20 bestselling prescription drugs in the United States today.

The global market for Dietary Supplements was estimated at USD 170.4 billion in the year 2020 out of which around USD 19 billion are herbal based.

Biodiversity of Sri Lanka

Sri Lanka is endowed with a rich flora and fauna. About 7500 plant species constitute the flora of Sri Lanka. Flowering plants constitute about 3360 species, belonging to 1350 genera and 200 families. The flora contains about 830 endemic species.

Some plant species are highly threatened. Out of the plant species occurring in Sri Lanka 1414 species are medicinal. Of these medicinal plants 208 are economically important, 79 species threatened and 50% heavily used in traditional systems of medicine in the country.

Traditional systems of medicine in Sri Lanka

From ancient times, Sri Lanka had a reasonably developed health care and delivery system to cater to the needs of the population. The ancient chronicle of the country tells of a hospital that was established in the capital city in the 4th century B.C. Ancient ruins of hospitals have been discovered in the then capital cities of the country and ancient surgical instruments too have been recovered. The system of treatment that existed in those times is called “Desheeya Chikithsa”. Later it was influenced by Ayurveda, Siddha and Unani systems which have been introduced to Sri Lanka from other countries. Medicinal plants play a main role in the traditional systems of medicine in Sri Lanka

Status of Medicinal Plants in Sri Lanka

The national demand for herbal materials for Ayurvedic drug manufacture was around Rs. 385 Mn annually. Most of the imported plants can be grown in Sri Lanka if a program of systematic cultivation and harvesting is introduced. In addition to imports, some exports of medicinal plants take place in small quantities. In the early periods, cinchona (*Cinchona officinalis* L.) bark, *Strychnos nux-vomica* L. seeds, *Gloriosa superba* L., *Catharanthus roseus* (L.) G.Don etc were exported. Later, exports of *Centella asiatica* (L.) Urb., *Aerva lanata* (L.) Juss. ex Schult., *Aloe vera* (L.) Burm.f., *Zingiber officinale* Roscoe, *Garcinia cambogia* Desr., *Murraya koenigii* (L.) Spreng. etc. took place.

Harnessing Green Gold for Human Welfare - The contribution of Industrial Technology Institute (ITI former CISIR)

ITI has a multidisciplinary R & D program on medicinal plants which includes

* Analytical studies & quality control of medicinal plants and herbal products.
* Agronomical and biotechnological studies
* Phytochemical, pharmacological and bioactivity studies

* Pilot scale processing of medicinal plants
* Development of value-added products from medicinal plants and transfer of technologies to industrialists
* Evaluation of Ayurvedic medicines.
* Community development programs
* Human resource development and provision of test reports to clients

Some highlights of the work carried out are given below.

Analytical studies & quality control of medicinal plants and herbal products.

***Cinchona officinalis* L.**

Sri Lanka has been associated with Cinchona since 1858. In 1886 the country produced ¾ of the world bark requirements. Subsequently the export declined but continued. Over 20 alkaloids were reported to be present in cinchona out of which quinine and quinidine were commercially important. Quinine had been used as an antimalarial drug and as a flavouring in soft drink.

In early 1980s a survey of the cinchona trees remaining in the tea estates and forests was undertaken. Samples (100) collected from locations ranging from 524m - 2330m were analysed. The total alkaloid contents of the samples ranged from 2-17% and quinine contents from 1-10 %. Plants growing in higher elevations had higher alkaloid contents than those at low elevations[3].

***Gloriosa superba* L.**

This plant grows in the shrub forests of Sri Lanka. The tubers are regarded as tonic, stomachic and anthelmintic, and extremely poisonous in large doses. Colchicine is the most important alkaloid used in plant polyploidy and in the treatment of gout. Good export market existed for seeds and some companies were involved in cultivation. The seeds, mother yams, sister yams, mature leaves, young leaves, and the pericarps were analysed to determine their colchicines contents and also to assist exporters by supplying reports on quality. Seeds had the highest content of total alkaloids (0.6 - 0.9) and colchicines (0.15-0.25). This was followed by mother yams and pericarps. In the leaves the contents were low[4].

***Adhatoda vasica* Nees**

This is an evergreen shrub belonging to the family Acanthaceae. It is a highly reputed medicinal plant used to remove phlegm, bile and purify blood. It is also recommended for cough, asthma, leprosy etc. In ayurvedic medicine five parts of this plant are used for preparation of a decoction blended with a sweet syrup. Vasicine is a major alkaloid in *A. vasica* and is reported to possess bronchodilatory and respiratory stimulant activities. The seasonal variation of vasicine was studied in five parts of *A. vasica* namely inflorescence, root, leaf, stem bark and petiole. The inflorescences had the highest content of vasicine followed by leaves, petioles, roots, and stem barks. The vasicine content was highest during the period July to September[5].

Agronomical studies

Agronomic studies on some commercially important medicinal plants listed below were carried out with the aim of introducing systematic cultivation in the country.

- *Catharanthus roseus* (L.) G.Don (S. Minimal)
- *Cassia angustifolia* Vahl (S. Senehe)
- *Solanum xanthocarpum* Schrad. (S. Katuwel batu)
- *Kaempferia galanga* L. (S. Hingurupiyali)
- *Piper longum* L. (S. Tippili)
- *Withania somnifera* (L.) Dunal (S. Amukkara)
- *Aloe vera* (L.) Burm.f. (S. Komarika)

***Catharanthus roseus* (L.) G.Don (S. Minimal)**
This plant belongs to Family Apocynaceae. The two alkaloids vincristine and vinblastine used as anticancer agents are present in the leaves. Ajmalicine present in the roots has antifebrile properties. As there is a demand for leaves and roots in the international market, agronomical studies of this plant were carried out.

In our studies to determine the optimum harvest time based on yields of total alkaloids and total dry matter, the best time to harvest the plant was found to be at 10th month of maturity.

The effects of foliar application of plant nutrients, manure and stress condition on total alkaloids and dry matter yield were studied. The foliar application of micronutrients and application of NPK and micro element mixture or NPK and cattle manure caused significant increases in the yield of dry matter and alkaloid contents.[6]

Large scale cultivation of *C. roseus* was carried out, seeds were collected and disseminated among farmers along with cultivation know how.

***Cassia angustifolia* Vahl** (S. Senehe) belonging to family Caesalpinaceae is a commercially important medicinal plant. It is an important member of purgative drugs containing sennosoides. Propagation and cultivation methods were worked out. The variation of the sennosoid content in leaves and pods with maturity was studied to determine the suitable time for harvesting

The results indicated that the pods contain more sennosides than leaves. This was maximum when the plants are around 120 days old. The leaves contain maximum sennoside content between 90-95 days. The sennoside content increased with increasing amounts of N- fertilizer and the results of weeding experiments showed that sennoside content increased with rice straw mulch.

Phytochemical and pharmacological studies

Tabernaemontana divaricata (L.) R. Br. ex Roem. & Schult. (S. Wathusudda) is a common ornamental plant. Various parts of this plant are used in the indigenous system of medicine for the treatment of skin diseases and as a remedy for cancer.

Ten indole alkaloids namely voacangine, voacristine, isovoacristine, coronaridine, isovoacristine, vobasine, voacangine, tabernaemontanine, 19-epivoacangine and a new compound 11- methoxy-N-methyl dihydropericyclivine were isolated and identified from the plant.[7]

***Rauvolfia canescens* L.** (S. wal ekaveriya) is used in folk medicine as a treatment for snake poisoning and for external application in skin ailments. In India, the roots are used as adulterants or substituents for *R serpentina.*

A new alkaloid named Lankenescine, in addition to nine more indole alkaloids namely ajmaline, yohimbine, α- yohimbine, isoreserpine, corybanthine, deserpidine, reserpiline, isoreser-piline, aricine were isolated and identified[8].

The extract of roots of *R. canescens* exhibited sedative activity in rats when evaluated using Rat Hole Board technique. No signs of toxicity were observed at the effective dose of 50 mg/kg.[9]

***Rauwolfia densiflora* (wall) Benth. ex Hook.f.** is a shrub growing in the mist forests of Sri Lanka at high elevations. It is used as an adulterant for *Rauwolfia serpentina* (L) Benth.ex kuz. Phytochemical studies indicated the presence of Ajmaline, vomifoline, peraksine, isoreserpiline and 3 new compounds Lankanesine, lankafoline and sridensine.

The alkaloid extracts indicated antibacterial activities against *Staphylococcus aureus* and *Escherichia coli*. Significant sedative activities were observed when the alkaloid extracts were

administered intraperitonially to rats and their exploratory behaviour was monitored. This was more prominent in the bark than in the leaves. Hence all three species of Rauwolfia occurring in Sri Lanka possess sedative activities[10].

Evaluation of Ayurvedic medicines

Evaluation of Ayurvedic medicines used for treatment of Arthritis

In this study, 200 traditional physicians in 10 districts were interviewed on drugs prescribed by them for the treatment of Arthritis. The data collected from the survey was computerized and evaluated. The results of the survey indicated that [11]

* Amavataya is the most commonly occurring type of arthritis.

* Rasna saptakaya prepared from 7 plants is the most common decoction prescribed by Traditional physicians.

* Deshanga lepaya is the most common paste applied in Arthritis.

Rasna saptakaya was selected for further studies. Toxicological, pharmacological and clinical studies as well as standardization of Rasna saptakaya were conducted.

Long term and short-term toxicological studies of Rasna saptakaya conducted on rats gave negative results.

Clinical studies were conducted at Ayurveda Hospital in Borella. The ages of the patients varied from 11-60 yrs. The joints involved in arthritis were knees in most cases followed by ankles. The patients were treated for a period of one month and examined once a week Clinical studies on 33 patients indicated that Lee's functional index had decreased after treatment for one month. Difficulties in the activities of daily living too had decreased when compared to the control group. Swelling had decreased after treatments. Longer period of treatment is necessary for a permanent cure.

The ingredients of Rasnasaptakaya are *Alpinia calcarata* (Andrews) Roscoe (S. Aratta) *Cassia fistula* L. (S. Ehelapotu) *Tinospora cordifolia* (Willd.) Hook.f. & Thomson (S. Rasakinda), *Cedrus deodara* (Roxb. ex D.Don) G.Don (S. Devadara), *Ricinus communis* L. (S. Erandu), *Tribulus terrestris* L. (S. Gokatu) and *Boerhavia diffusa* L. (S. Sarana). As *A. calcarata* is commonly found in most of the decoctions prescribed for arthritis, detailed studies on the plant were carried out.

***Alpinia calcarata* (Andrews) Roscoe**

In Sri Lankan traditional medicines decoctions of *A. calcarata* rhizome are widely used in the treatment of bronchitis, cough, respiratory disorders, asthma, arthritis, and diabetes. The Gas Liquid Chromatographic determination of the constituents of *A. calcarata* volatile oil indicated the presence of camphene, β pinene, limonene, 1,8 cineole, camphor, α-terpineol, fenchyl acetate, cadinene and caratol. 1,8 cineol was the major component in rhizomes and leaves while in the roots it was fenchyl acetate.[12]

Analgesic activity of the hot water and ethanolic extracts of *A. calcarata* was determined using Hot plate test, Tail flick test and Formalin test. A dose of 500 mg/kg of extract significantly increased the reaction time in Hot plate test[13].

In the study of anti-inflammatory activity, the inhibition of Carrageenin induced rat paw edema was determined for hot water and ethanolic extract of *A. calcarata* & Indomethacin. The *A. calcarata* hot ethanolic and hot water extracts possess significant anti-inflammatory activity. Anti- inflammatory potential in hot ethanolic extract was higher than that of hot water extract. Edema inhibition of *A. calcarata* hot ethanolic extract at 500 mg /kg level is comparable to that of Indomethacin which is the positive control.

A. calcarata extracts were assessed for hypoglycaemic potential using following methods.

- Normoglycemic rats (both in fasted and non-fasted states)
- Streptozotocin - induced diabetic rats
- Oral glucose tolerance
- Glucose absorption from intestine
- Accumulation of glycogen in liver and skeletal muscle

In addition, toxicological studies were carried out for both extracts.

The presence of insulin was found to be essential for hypoglycaemic activity of *A. calcarata* and the extracts stimulated the insulin activity. This finding is beneficial to patients suffering from Type 2 DM which is the commonest type in Sri Lanka.

The extracts were devoid of unacceptable side effects even following chronic oral administration.

The antifungal assay indicated that the essential oil of *A. calcarata* rhizomes is active against *Fusarium* spp., *Curvularia* spp., & *Colletotrichum* spp. Compared with the positive control Daconil, the essential oil of *A. calcarata* has better activity indicating that the fungi species are more sensitive for essential oil than Daconil.

Studies revealed the anti-inflammatory, analgesic, antioxidant, gastroprotective, antifungal, hypoglycaemic activities of *A. calcarata* and its safety profile indicating its true nature as a Green Gold .

***Piper betle* L.**

Betel is cultivated in Sri Lanka, India, Malaysia, Indonesia, Philippine, and E. Africa. The leaves are traditionally used for chewing with condiments in Sri Lanka.

Leaves are applied for cuts , wounds and boils and are stomachic & febrifuge. It is given to children for cough and used to treat night blindness. Stimulant, antiseptic, carminative, astringent, and aphrodisiac properties are reported. Several Betel cultivars occur in Sri Lanka. Some of them are Maha maneru, Kaha kiriya, Kalu bulat, Wel bulat, Ratadalu, Garandi maneru, Galdalu, Nagawalliya, Kaha bulat, Matipala, Gatathodu, Kaha Maneru.

From GLC studies the chemical constituents of *P. betle* essential oil were found to be Pinene (1.2%), Terpineol (1.9%), Phellandrene (4.6%) Elemene 2.9%, Iso terpinolene (1.6%) Muurolene (4.1%), m- Cymene (1.1%) Safrol (34.9%), Limonene (1.5%), Eugenol (11.2%), 1,8 Cineol (1.9%), Chavibitol acetate (5.9%) , Linalool (0.7%) Allyl pyrocatechol diacetate (6.8 %).

The water and ethanolic extracts of *P. betle* of Sri Lanka were subjected to pharmacological studies. Antioxidant, analgesic, antibacterial, antifungal gastroprotective, Antidiabetic and antidiuretic activities were detected., Toxicological studies gave negative results.[14] One cannot imagine that the common mans' chew can have so many beneficial properties.

Community development programs

Development of value-added products from medicinal plants for community based rural development program.

Ritigala mountain lying in the north central province, rich in rare medicinal plants is a Strict Nature Reserve. People living in the surroundings grow medicinal plants and produce drugs at home. RITICOE is a nongovernmental organization involved in community development programs and manufacturing of drugs from medicinal plants. ITI Standardised and improved the quality, the production process and marketability of 7 Ayurvedic medicines produced by RITICOE. Monographs containing quality control parameters of 7 drugs , information on the

100 raw materials and their identity were prepared and handed over to staff. Value added products were prepared from medicinal plants found in the community and training programs were conducted for rural folks. A processing centre was designed and the drug manufacturing facilities of RITICOE was improved.

Development of value-added products from medicinal plants and transfer of technology

Several value-added products such as Herbal shampoos, Herbal creams, lotions Herbal soups, Moisturisers, Herbal porridge, Aloe burn cream, Herbal toothpaste, Herbal mouthwashes, Herbal wound creams, Instant betel chew, Pet lotions, shampoos & pellets, Antioxidant have been formulated at the request of local industrialists and technologies transferred to them.

Information and coordination in the sector
Data bases

A data base containing information of 100 medicinal plants had been prepared . This was used to provide information on medicinal plants to ITI clients.

International & regional networks

Asia - Pacific Regional Network for Traditional Medicine and Herbal Technology (APTMNET) was set up by APCTT. ITI was the focal point in Sri Lanka, and I functioned as the coordinator of the local station. The nodal station had been set up and information entry was in progress. This station will be linked to the stations in Asia Pacific countries and internally to institutes dealing with traditional Medicines This network enabled information exchange on traditional medicine, herbal technology, and production development in Asia Pacific region at that time.

As the country representative of the Asian Network on Medicinal and Aromatic Plants (ANMAP) I provided relevant local information to the bimonthly Newsletter NANMAP.

Catharanthus roseus (L.) G.Don

Cassia angustifolia Vahl

Aloe vera (L.) Burm.f.

Kaempferia galanga L.

Alstonia macrophylla Wall. ex G.Don

C. roseus cultivation

Alpinia calcarata (Andrews) Roscoe

Cultivation *of P. longum* under coconut

Rauwolfia canescens L.

Cinchona officinalis L.

Acknowledgments

1. National Science Foundation, CARP, International Foundation for Science – Sweden International Development Research Centre (IDRC) – Canada

2. Team of Researchers -P.G. Madawela, M.A.N. Kumudini, L.A. Goonetilake, H. Ratnayake, T. Ranatunge, J. Ranatunge, C.K. Ratnayake, W.D. Ratnasooriya, A. Kumarasinghe, M. Arawwawela, G.A.S. Premakumara R. Dissanayake R.L.C. Wijesundera, C.S. Basnayake, P. Serasinghe, S.B.A. Wimalasiri, S. Wijeratne P. Fernando, K. Wickremasinghe, R. de Costa

References

1. The 1999 list of threatened Fauna and Flora of Sri Lanka- IUCN Sri Lanka

2. Sri Lanka Conservation and sustainable use of Medicinal Plants project report (2001.)
3. L.S.R. Arambewela, L.A. Goonetillake, R de Costa (1984), J. Natn. Sci. Coun. SL,12 (1)
4. L.S.R. Arambewela, M.A.N. Kumudini, J. Ranatunge (1991), J. Natn. Sci. Coun. SL, 19(2), 177
5. L.S.R. Arambewela, C.K. Ratnayake, J.S. Jayasekera (1983), Fitotherapia 18 2.
6. Lakshmi S. R. Arambewela, J. Ranatunge, Shantha Wijeratne, Pushpa Fernando, Kamani Wickremasinghe (1993), J. Natn. Sci. Coun. Sri Lanka 21(1) 63-71
7. L.S.R. Arambewela T. Ranatunge (1991), Phytochemistry 30, (5)1740
8. L.S.R. Arambewela, P.G. Madawela (2001), Pharmaceutical Biology 39 (1), 239
9. P.G. Madawela, L.S.R. Arambewela , G.A.S. Premakumara and W.D. Ratnasooriya (1994), Journal of Ethnopharmacology 42, 63
10. S.W. Weerakoon, L.S.R. Arambewela, G.A.S. Premakumara and W.D. Ratnasooriya (1998), Pharmacological Biology 36,360
11. Chandana Basnayake, Lakshmi Arambewela, Palitha Serasinghe, M. H. A. Tissera, Sunethra Dias, D.R. Weerasekera Traditional treatment in Sri Lanka for chronic arthritis – A Surey -
12. Lakshmi Arambewela, Ajith Kumarasinghe, Menuka Arawwawela, Noel Owen, Li Du (2005), I. Essent. Oil Res. 17, 124
13. L.S.R. Arambewela, L.D.A.M. Arawwawela, W.D. Ratnasooriya (2004), J. of Ethnopharmacology 95, 311
14. L.S.R. Arambewela, L.D.A.M. Arawwawela, W.D. Ratnasooriya (2003), I. Trop. Med. Plants 4(2) 195

The tissue of life to be
We weave with colors all our own
And in the field of destiny
We reap as we have sown

John Greenleaf Whittier (1807-1892)

The time has come when we cannot be so careless. Unless we do better, we may suffer through a stark emergency of the environment. We may create a hostile world: a world to bruise ourselves against; a world of sprawling cities, unplanned or badly planned; a world whose water is full of sludge, whose winds are full of soot; a world whose landscape has been totally neglected, stripped, marred, and wasted. All of this need not happen if we choose well, and particularly if we plan well and if we act well.

- Lyndon B. Johnson

Today's environment is beginning to threaten today's organizations, finding them seriously deficient in their nervous system design… The degree of coordination, perception, rational adaptation, etc., which will appear in the next generation of human organizations will drive our present organizational forms, with their clumsy nervous systems, into extinction.

- Douglas Engelbart

"Exercise itself, which tends to be highly repetitive when engaged in regularly, is a major driver of neuroplastic changes in the brain, which is why physical exercise is one of the most important factors in restoring and maintaining mental as well as physical health across the life span, starting from the moment one begins such a program."

Bob Stahl, A Mindfulness -
Based Stress Reduction Workbook

QUALITY ASSURANCE IN TESTING LABORATORIES –WAY FORWARD

*By Subadra Jayasinghe**

Introduction

Testing laboratories play a major role in providing analytical reports for the benefit of consumers as well as manufacturers in assessing product quality and monitoring the production process by testing the quality of intermediate products and raw materials.

Testing involves conducting many measurements and the test result is derived from several observed values involving many measurements. The test result is therefore the final reported outcome of analysis.

Testing laboratory can be aptly described as the following:

IS WHERE MEASUREMENTS ARE MADE

WHERE UNKNOWNS BECOME QUANTIFIED

WHERE SAMPLES TURN INTO DATA

AND

DATA INTO INFORMATION

UPON WHICH DECISIONS ARE MADE

Therefore, a testing laboratory plays a pivotal role in a production process or any other activity where test results are used by a third party and hence need to be independent, unbiased and should be capable of delivering valid analytical results.

The concept of 4Ms (Man, Machine. Method and Materials) in a production process is well known and the same could be applicable to a testing laboratory.

The 4Ms in a Testing Laboratory could be interpreted as follows:

Man - Personnel (Decision makers, Analysts and supporting staff)

Machine - Equipment (Instruments and Glassware)

Method - Test methods and applicable procedures and work instructions for operational activities

Materials - Chemicals, reagents, microbiological media, reference materials and reference cultures

In addition to above, the laboratory environment plays a key role in achieving valid analytical results.

The testing laboratory needs to implement policies and procedures to ensure that results are unbiased, and that the laboratory undertakes testing services impartially and all information are well managed to ensure confidentiality.
Implementation of appropriate quality assurance practices by way of internal quality control is an important step towards achieving validity of test results.

The Figure 1 given below summarizes the sum of the activities of a testing laboratory.

---

* *Subadra Jayasinghe was the Head of the Quality Assurance Department of the ITI at the time of retirement and now serves as the Senior National Expert for the project on Strengthening Quality Infrastructure in Sri Lanka of the PTB (National Metrology Institute) of Germany and as the Proficiency testing Coordinator of Association of Testing Laboratories - Proficiency Testing (SLAB Accredited). She previously served UNIDO as a National Consultant on Laboratory accreditation and International Consultant in Proficiency testing.*

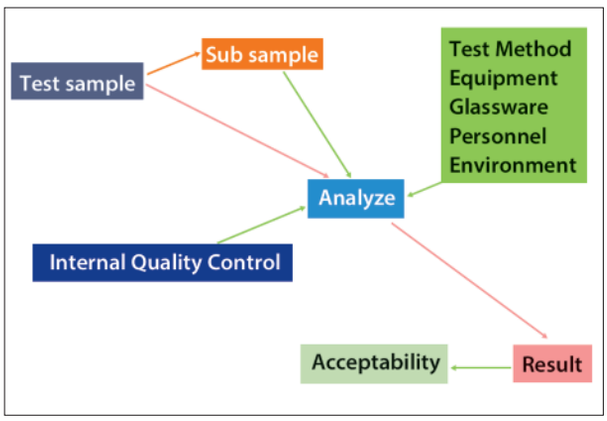


Figure 1. The sum total of Activities aimed at achieving Validity of Results

Personnel

Competent personnel for identified tasks of the laboratory plays a major role in achieving valid analytical results. Competency includes, the educational qualifications, obtaining appropriate training to achieve the needed technical knowledge and skills to perform testing and associated activities.

Training of personnel to impart the required knowledge and skills to perform identified activities needs to be planned for new recruits of all levels and based on performance evaluation of personnel already employed or when new testing methods are to be introduced or on procurement of new equipment.

Training evaluation to assess the level of competence has to be carried out prior to assigning any task. Authorization to perform a particular task is always given after training and competence evaluation. The authorized personnel should be monitored on a regular basis to ensure continuing competence.

The duties, responsibilities and authorities of all laboratory personnel has to be clearly defined and communicated individually.

Equipment

Correct performance of equipment plays a key role in achieving valid analytical results. The selection of correct equipment is the first step towards meeting this target. Therefore, the laboratory needs to adopt procedures for procurement of equipment where the specifications of equipment to be purchased are checked for accuracy and the needed requirements of the laboratory. Once a new equipment is received the laboratory has to check it for correct performance and verify before placing in service and maintain records.

The traceability of measuring equipment to International Standards is also an important requirement to achieve accuracy of test results. Calibration of measuring equipment by an accredited calibration laboratory having a documented unbroken chain of calibrations to appropriate stated references assures traceability of measurements to international Standards. The laboratory analysts should be trained in reading the calibration report correctly and make use of the information provided such as uncertainty of measurements and correction factors if any.

The equipment should be located under appropriate environmental conditions and the environmental conditions must be monitored at regular intervals.

Sensitive measuring equipment must be located away from interferences such as vibrations, excessive heat, and air drafts.

Preventive maintenance of equipment is another important factor in testing. The laboratory must have a preventive maintenance plan based on the instructions given in the instruction manual of the relevant equipment.

Test methods and procedures

Test Methods

Test methods used by laboratories are based on methods published in National or regional or International Standards, methods published by

recognized International bodies such as Association of Official Analytical Chemists (AOAC), American Public Health Association (APHA), American Spice Traders Association (ASTA) etc., as prescribed in relevant regulatory requirements such as Food Act of the Government of Sri Lanka for local food safety requirements or international bodies such as Food and Drugs Authority (FDA) of USA or European Union or regulations of other countries for products intended for export.

Laboratories also use methods published in scientific test books or scientific journals or sometimes as per manufacturers' instructions in case of use of high-end equipment.

Most of the national, regional, and international standards and recognized international organizations are regularly reviewed and new editions of textbooks are issued and hence the laboratories must assure that the methods given in current valid edition is used.

Method validation and verification are two important aspects to prove that the method is fit for purpose so that the laboratory will have confidence to perform the test in the laboratory. Method validation is basically the process of defining an analytical requirement and confirming that the method under consideration has capabilities consistent with what the application requires (Eurachem, 2014).

The methods published in national, regional, or international standards and by reputed international organizations such as AOAC and APHA or complete measuring system to be used for a specific application from a commercial manufacturer are validated by collaborative studies and relevant data are published.

However, the laboratory needs to confirm that it can be performed accurately in the laboratory and this process is termed method verification. Method verification is important as there are many factors that can affect the test result as it gives assurance that the method can be performed correctly in the laboratory with the available equipment, personnel and the laboratory environment that is maintained.

Method verification performed by a laboratory enables to determine the precision and accuracy of the results and the range of measurement of a particular test method. This could be performed by use of similar matrices with known value and determining the Bias or participating in a performance monitoring programme. In the case of microbiological analysis, method verification could be performed by using traceable microorganisms (e.g., ATCC Cultures) and determining the recovery.

Method validation is required for in-house developed methods and methods published without validation data or if a standard or validated method is altered.

Precision is defined as the closeness of agreement between measured values obtained by replicate analysis (NATA 2012) which is the repeatability of the laboratory for a particular test.

Validation procedure involves defining certain characteristics namely:

Accuracy

Precision

Range

Linearity

Robustness

Calculation of measurement uncertainty of the result which is defined as a parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand (ISO/IEC Guide 98-3) is an important requirement in testing. The value for measurement uncertainty represents the possible dispersion of the result due to personal error,

instrument characteristics, purity of chemicals, temperature variations during analysis etc. and this needs to be used when reporting conformity of test results to stated specifications.

Traceability of measurements is another factor that can affect the validity of results. All measurements must be traceable to International Standards. In any analysis measurements (e.g., mass, volume, optical density etc.) being carried out, and traceability of these measurements is achieved by having measuring equipment calibrated by accredited calibration laboratories as stated under the section on equipment.

Use of Certified Reference Materials as discussed under Quality Assurance enables to establish traceability in chemical measurements. A typical example is measurement of pH which is usually done daily in the laboratories and the instrument is calibrated using buffer solutions commercially available. It is very important that the laboratories purchase buffers with traceability to International Standards.

In microbiological analysis traceability of measurements is achieved by use of reference cultures from a standard reference culture collection.

Chemicals, Reagents, and other consumables

The laboratory needs to identify the correct grade and purity of the chemicals and reagents that are to be used for analysis as per the defined test method. The expiry dates of reagents and microbiological media needs to be given due consideration. All incoming chemicals, reagents and other critical consumables must be checked for specifications defined by the laboratory and suitability for use.

Standard solutions, reagents and microbiological media prepared in the laboratory must be clearly labelled with date of preparation and expiry date. Traceability to preparation data must be recorded and made available when required.

Environment

Working environment plays a key role in achieving valid test results. Some tests require conditioning or stabilizing the test items before analysis. The temperature and humidity requirements are important considerations in such situations and daily monitoring records should be available.

An appropriate housekeeping plan needs to be developed by the laboratory to ensure cleanliness of the working environment and hygienic quality in the case of microbiology laboratories.

Quality Assurance

Quality assurance practices implemented in a laboratory is a key factor in ensuring validity of results. The International Standard ISO/IEC 17025:2017 identifies several activities that could be implemented in the laboratory.

Replicate analysis of test items enables the laboratory to ensure the required precision and is defined as the repeatability of measurement which is the difference between the replicate results obtained for the same sample, analysed by the same analyst under the same working conditions. Use of reference materials to assess the validity of test results must be practiced by laboratories with a suitable frequency or run parallel with each test. Control charts which are a simple graphical display in which observed values are plotted versus the time of analysis. The control limits in control charts must be identified with ±2 standard deviations as warning limits and ±2 standard deviations as the control limits. Laboratories are encouraged to use Certified Reference Materials (CRM) which could be purchased from reference material producers who are accredited to ISO/IEC 17034: 2016 the general requirements for the competence of reference material producers (RMPs). Laboratories can also use secondary reference materials provided by Proficiency Testing providers or in-house prepared reference materials in the absence of CRMs.

Participating in Proficiency testing (PT) enables laboratories to assess their level of performance and participation frequency required is at least once in 3 years. Proficiency Testing is provided by accredited PT providers having achieved conformity to ISO 17043:2010 requirements for Conformity assessment — General requirements for proficiency testing.

In addition, laboratories can assess their level of performance through inter-comparison studies with other laboratories accredited for the required parameters and appropriate data analysis.

Achieving competency

Testing laboratories can achieve competency in issuing valid test results as discussed above and can prove their competency by implementing the Quality Management System (QMS) in conformity to ISO/IEC 17025:2017 and achieving accreditation.

A test report from an accredited testing laboratory, bearing the accreditation logo of the national accreditation body is accepted worldwide for international trade. Hence having accredited testing facilities is a boost to international trade to meet the global trade requirements.

References

1. ISO/IEC 17025: General requirements for competency of testing and calibration laboratories
2. ISO/IEC 9001:2015 Quality management systems Fundamentals and vocabulary
3. The Fitness for Purpose of Analytical Methods A Laboratory Guide to Method Validation and Related Topics, Eurachem, 2nd Edition, 2014
4. Technical Note 17 Guidelines for the validation and verification of quantitative and qualitative test methods
5. ISO /IEC Guide 98-3:2008, Guide to expression of uncertainty in measurement
6. Metrological Traceability in Chemical Measurement A guide to achieving comparable results in chemical measurement 2nd Edition in English 2019
7. ISO 17043:2010 requirements for Conformity assessment - General requirements for proficiency testing

"A man may esteem himself happy when that which is his food is also his medicine."

Henry David Thoreau

All those spices and herbs in your spice rack can do more than provide calorie-free, natural flavourings to enhance and make food delicious. They are also an incredible source of antioxidants and help rev up your metabolism and improve your health at the same time.

Suzanne Somers

Consult not your fears but your hopes and your dreams. Think not about your frustrations, but about your unfulfilled potential. Concern yourself not with what you tried and failed in, but with what it is still possible for you to do.

Pope John XXIII

CARDAMOM : THE QUEEN OF SPICES

By A L Jayawardene and Dilmani Warnasuriya

Preamble

Spices are an indispensable commodity used by man from ancient times to enhance the taste of foods. Indeed , the word spice is so deep rooted as something that adds verve and that little something extra to life, that the phrases 'variety is the spice of life' and 'spice it up' are used to indicate this. And so, the epithet of "Queen of Spices" would not have been given to a common run- of- the- mill spice. This is the term Cardamom (*Elettaria cardamomum* (L.) Maton) has earned for itself, being second in popularity to the King of Spices, Pepper (*Piper nigrum* L.). Cardamom is a highly valued spice crop not only in the culinary field but in the pharmaceutical arena, and in other areas as well. In Sri Lanka, it is an indispensable adjunct in Sri Lankan cookery as in several other countries. The famed Sri Lankan yellow rice (kaha buth) prepared for all festive occasions, for instance, takes its unique flavour from the cardamom sometimes put into the rice in a little packet along with other spices. It has a strong pungent flavour which may not be palatable on its own, but a little bit goes a long way, and thus in small amounts it imparts an inimitable flavour. The middle eastern coffee is also strongly flavoured with a generous portion of crushed cardamoms.

Historical records

Cardamom has a history which dates back to Vedic times, about BC 3000. In the ancient texts, it is referred to as Ela, in Sanskrit. In Hindu culture, it is reported that cardamom was used as an ingredient in the sacrificial fires which was a common ritual in those times. Both the *Charaka Samhita* and *Susrutha Samhita*, the ancient Indian Ayurveda texts, regarded as the bibles of Ayurveda in India, written in the post Vedic times (BC 1400 – BC 1600), also mention cardamom.
Not only Indians but even Assyrians and Babylonians considered Cardamom as a valuable herb and was even grown by the King of Babylonia who reigned from BC 721- BC 702 in his herb garden. In Ancient Greek and Roman texts, it is cited as an ingredient for perfumery even considered as a symbol of luxury and royalty, and as an aphrodisiac. Apart from these attributes, Greeks and Romans also considered it as a useful aid to digestion, and this led to large quantities of the spice being imported from India, and this was applicable to Egypt as well, although there was no time frame for the latter. However, some records show that cardamom is mentioned in an Egyptian papyrus as early as 1550 BC. Ancient Egyptians used Cardamom for many medicinal purposes, as part of rituals and even for embalming. They chewed cardamom pods to help keep their breath minty and to help clean their teeth. The use of this spice dates back at least 4000 years and is thus considered one of the oldest spices known to mankind.

Nomenclature

Common Name : Cardamom

Latin Name/s :

Elettaria Cardamomum (L.) Maton
Elettaria ensal (Gaertn.) Abeyw.

Sinhala names : Ensal, Karadamungu

Tamil names :

Ella-kai, Yelakkai; Akym; Periayalam

Other Names : Capalaga, Ilachi, Green Cardamom, True Cardamom, Ceylon Cardamom

Pale green color Cardamom pods

Cardamom, also spelled **cardamon,** is a herbaceous perennial plant belonging to the ginger family or Zingiberaceae. The name is derived from the word Elettaria which means granules of leaf in Tamil which is the language used in South India and also among the Tamils in Sri Lanka. The genus *Ellataria* consists of seven species but in fact only *E. cardamomum* is predominantly grown in India, a fact that is little known. The species *E. ensal* is what is found in Sri Lanka in the wild and is a larger and sturdier plant than the Indian species and it is known as the wild Cardamom. However, the Indian varieties are also cultivated in Sri Lanka commercially. Several species have also been identified from Malaysia and Indonesia. Consequently, even today, absolute identification of the different varieties and species growing in India and Sri Lanka seems to be a cause of confusion as many authors provide different nomenclatures. In one of the earliest descriptions of cardamom two varieties of Cardamom were identified, one being confined to South India, this having narrower and less firm leaves, and globose fruits of small size , and the other variety shorter of stem and broader leaves with oblong fruits of larger size, this being the Ceylon cardamom and is peculiar to this country. In another historical review, three varieties were identified, as being the indigenous Ceylon, the Malabar, and the Mysore.

True cardamom is commonly known as small cardamom and is grown in many countries predominantly India, Sri Lanka, and Guatemala. It is green in color as against the false cardamom which is black in color and is larger and comes from the genus *Amomum* and is native to Nepal.

Harvested green cardamom pods

Cardamom plant

Cardamom flower

Botanical description

The small cardamom plant is a herbaceous perennial that grows 2-5 m in height with thick irregular shaped underground rhizomes and is propagated by vegetative division of rhizomes. The aerial stem is formed by encircling the leaf sheaths and could be called a pseudo stem. Leafy shoots of the cardamom plant arise 1.5 to 6 m (5 to 20 feet) from the branching rootstock. Flowering shoots, approximately 1 m (3 feet) long, may be upright or sprawling; each bears numerous flowers about 5 cm (2 inches) in diameter with greenish petals and a purple-veined white lip. The whole fruit, 0.8 to 1.5 cm, is a green three-sided oval capsule containing 15 to 20 dark, reddish brown to brownish black, hard,

angular seeds. Flowers are mostly white with the central lip streaked with pin . Leaf blades are 30-35 cm long and 7-10 cm wide, lanceolate, and dark green in color.

The wild cardamom which is native to Sri Lanka can be distinguished from the commercial varieties by the light pink anthocyanin pigmentation in the stems, petioles, and leaf sheaths. The leaves are broader, and fruits are longer and less regular than others. Cardamom pods are spindle-shaped and have a triangular cross-section. The pods contain several seeds, which are small and black, while the pods differ in color and size by species. Cardamom is generally available in the form of whole fruit as a primary product, in ground form as secondary processed products and in the form of extractions of oil and oleoresin as value-added products. Cardamom lands are generally termed as spice forests.

The Chemistry of Cardamom flavor & fragrance

While studies into the volatile chemical composition of the essential oils of the various spices were carried out at the beginning of the last century, the application of modern analytical techniques to the study of the essential oils of cardamom grown in Sri Lanka and commercial oils was performed by R.O.B. Wijesekera and Richard Bernard while he was a Post-Doc. at University of California, Davis campus in 1969. The table below shows these results and comparative data with some Indian cardamom oils

Peak No. (see Fig.2)	Constituent	Confirmed Identity*	Reference†
2	α-Pinene	RD,PE,i.r.	9-12
3	Camphene	RD	
5	Sabinene	RD,i.r.	6,8-12
6	β-Pinene	RD	9
8	Myrcene ; α-terpinene	RD,PE	9-12
9	α-Phellandrene	RD	
13	D-Limonene	RD, i.r.	4,9-12
14	1,8-Cineole	RD, i.r.	3,10-12
15	Methylheptenone	RD	10,11
17	γ-Terpinene	RD, i.r.	7,9
19	*trans*-Sabinene hydrate	RD	2‡,12
26	Linalool	RD,i.r.	10,12
29	DL-Camphor	RD	
33	β-Terpineol ; citronellal	RD, PE	10,11
34	DL-Borneol	RD, PE	6,10,11
38	4-Terpinenol	RD, i.r.	7,8,12
42	α-Terpineol	RD,i.r	3,10-12
48	*trsns*-Citral	RD	
52	Citronellol	RD	
53	Nerol	RD,PE	10-12
57	Geraniol	RD, i.r.	10,11
61	4-Terpinenyl acetate	RD,i.r.	2
62	Asaridole	RD	
70	α-Terpinyl acetate	RD,i.r.	3,10-12
72	Neryl acetate	RD, i.r.	10-12
76	Geranyl acetate	RD, i.r.	
106	Bisabolene ; *trans*-nerolidol	RD	
110	*cis*-Nerolidol	RD	10-12
134	Farnesol	RD	

* Key : RD, GLC retention data ; PE, peak enhancement ; i.r. infrared spectrum.
† Compounds previously reported in the literature. See references in text.
‡ Reported in Guenther[2] as an unknown solid, m.p. 60-61^0.

** OV-101 a dimethyl silicone of approx. mol. wt. 30,000 and a viscosity of *ca.* 1200 cs.
†† SF-96 is also a dimethyl silicone of unspecified mol. wt. and a viscosity of ca. 50 cs.

Constituents identified in Cardamom oils

Source : Bernhard, Wijesekera and Chichester: Phytochem: Vol. 10 Iss.1(1971) pp.177-184

As seen from this table the oils from the Malabar varieties of Ceylon and Guatemala show quantitative difference in the distribution of the volatile components. One of the main features of this analysis was that principal components of the all-commercial cardamom volatile oils were two compounds 1,8-Cineole and α-Terpinyl acetate. This author (A.L.J.) found that simply mixing these two pure compounds in roughly equal volumes gave a mix which smelled very close to cardamom oil, it was only when the mix was allowed to evaporate off a blotter that the differences from authentic cardamom oil were observed. It must be pointed out that the results in last 4 columns of the table are from oils expressed from dried spice by high pressure while the NF-Cardamom oil is a commercial product obtained by steam distillation, the usual method of preparing essential oils on a commercial scale. The higher Cineole content is due to larger release of this component during steam distillation. The wild Ceylon type cardamon gave an oil materially different in composition from commercial cardamom oils. The two principal components of commercial Cardamom oils were present only at less than 5%, while other terpene compounds such as α-Pinene, γ-Terpinene and trans-Sabinene hydrate were present in more than ten percent level. Obviously, this oil cannot impart the typical cardamon flavor by any means. Its commercial value is unknown as at present.

Cultivation of Cardamom

Cardamom is a shade loving plant and grows best at an altitude between 600-1500 m above mean sea level, and temperature range of 10 - 35 ^{0}C. Warm and humid conditions are preferred for optimum growth. At one time some of the most productive cardamom plantations in Sri Lanka were in the Mathurata region, where the spice was grown under partial shade of montane forest canopy. Unfortunate land reforms caused havoc among these private plantations. It is felt that some industries are best left to private entrepreneurs who can devote much care and attention to the plantations, unlike the state sector which cannot do this. Thus, the industry did not flourish as expected.

Cardamom cultivation at Longwa village in Nagaland

Cardamom cultivation was concentrated in the evergreen forests of Western Ghats in South India. However, now the crop is grown commercially in Guatemala and on a smaller scale in Tanzania, Sri Lanka, El Salvador Vietnam, and other Asian countries. While India dominated the production several years back, Guatemala has now taken over and contributes to over 48% of the world market. In some parts of Guatemala, it is considered even more valuable than coffee as a crop.

In Sri Lanka, cardamom is mainly cultivated in the districts of Kandy, Matale, Kegalle, Nuwara Eliya, Ratnapura and a part of Galle. Three types of Cardamom are found in Sri Lanka, and they are categorized based on the shape of the inflorescence.

- Malabar – Inflorescence is prostrate.
- Mysore – Inflorescence is vertical.
- Vazhukka- Inflorescence is inclined.

Cardamom plants in the Knuckles Mountain range

Processing

Cardamom fruits are picked or clipped from the stems just before maturity, cleansed, and dried in the sun or in a heated curing chamber (this is the preferred method since it preserves the beautiful pale green shade of the fruits). Cardamom may be bleached to a creamy white colour in the fumes of burning sulphur. After curing and drying, the small stems of the capsules are removed by winnowing. Decorticated cardamom consists of husked dried seeds.

Ceylon Cardamom as known commercially, is green in colour and has a unique flavor probably due to the terrain and climate prevailing in the country. Green cardamom is one of the most expensive spices by weight. However, since it has such a strong flavor, a little goes a long way.

> Tell me, I'll forget. Show me, I may remember. But involve me and I'll understand.
>
> *Chinese proverb*

Cardamom picking and grading process in India

Health Aspects

Cardamom is valued as the third most expensive spice in the world after Saffron (*Crocus sativus* L.) and Vanilla (*Vanilla planifolia* Andrews) It is mentioned in Greek medical tomes as a folk remedy for such ailments as coughs, abdominal pains, spasms, and sciatica (Davis,2005). Those of us Sri Lankans who were born prior to 1950 are sure to have undergone treatment for worm infections and this consisted of small dose of Calomel, which is mercurous chloride, and santonin an alkaloid, followed by a purgative mixture made up of Epsom salts tinted a deep

pink color with a Tincture Cardamom compound (Card-Co tincture) as specified by the British Pharmacopeia. In addition to its flavor the extract of cardamon is considered a carminative on the nervous system. As usual with many folk medicaments' cardamom is considered a panacea for many ailments such as pain, swellings, bronchitis, diarrhea, and nausea. There are claims that cardamon seeds possess multiple biological roles among which are antioxidant, antihypertensive, antidiabetic, gastroprotective, laxative, antibacterial and even anticancer activities.

The oil from cardamom is reported to have strong antibacterial activity against several microbes and inhibited the growth of Listeria monocytogenes, *Staphylococcus aureus, Escherichia coli, Yersinia enterocolitica, Pseudomonas aeruginosa, Lactobacillus plantarum, Aspergillus niger, Geotrichum candidum* and Rhodotorula). Furthermore, cardamom oil is reported to inhibit the growth of food-borne viruses and fungi. There is strong evidence that natural antioxidants are safer and possess several potential health benefits due to their effective free radical scavenging properties. One study reports that cardamom oil is effective in boosting levels of glutathione (a natural antioxidant in the body) in a dose-dependent manner from 100 to 5000 ppm. It is reported that in accordance with new developments of novel food products a range of cardamom-derived products have been launched. In order to facilitate these efforts cardamom flavor has been encapsulated. Such spice products have some unique features, the most important being consistency of flavor strength and instant flavor release and dispersion thus ensuring ease of preparation of even large batches of a product without fear of hot spots. Food scientists are innovating new and more appealing food products using modern technologies.

Market for Cardamom

Ceylon Cardamom is available in various forms in the global market.

- The whole Cardamom is the whole pod, with seeds intact.
- Ground cardamom is the cardamom powder. Cardamom is usually known for having a reduction of flavour once the seeds are ground but is used in culinary recipes. It is thus considered best to grind the cardamom just prior to using it.
- Cardamom oil is the essential oil derived from cardamom pods through steam distillation.

Cardamom powder and Cardamom essential oil

The country serves about 0.1% of the global demand for cardamom which amounts to 4000 to 5000t per annum. India, Australia, Canada, and Estonia are the main buyers of Ceylon Cardamom, which is available in two grades: namely LG Lanka Green Cardamom (LG) and Lanka Light Green Cardamom (LLG).

Consumption of cardamom has gone up extensively throughout the world during the last two decades, and this is reflected in the prices seen in the local market as well. Cardamom is mainly consumed in the Middle Eastern countries, India, Pakistan, European countries, the USA, and Japan. In fact, Middle Eastern countries such as Saudi Arabia and the United Arab Emirates, and South-East Asian countries such as India, account for over 60% of the global consumption.

Conclusion

Presently, the cost of Cardamom is so prohibitive to the normal housewife, that frustration sets in when venturing into the kitchen for the preparation of a meal where cardamom is a necessary adjunct. Surely, in a country, where conditions are ideal for the cultivation of cardamom much could be done to bring down the price to the local user? Subsidies, incentives to growers, or similar alternatives are some choices to lighten the load of the local consumer. Exports are necessary, but here again emphasis should be on value addition rather than on the raw product. It is hoped that Cardamom could increase its holding in the world market and live up to its name in Sri Lanka as the Queen of Spices.

Acknowledgements

The willing assistance rendered by Ms. Nadeesha Gunasekera in providing diagrams, pictures, referencing and editing of the document is gratefully acknowledged.

References

1. Nair, K. P. (2020). The Geography of Cardamom (*Elettaria Cardamomum* M.). Springer International Publishing.
2. Ashokkumar, K., Murugan, M., Dhanya, M. K., & Warkentin, T. D. (2020). Botany, traditional uses, phytochemistry and biological activities of cardamom [*Elettaria cardamomum* (L.) Maton]–A critical review. Journal of ethnopharmacology, 246, 112244.
3. El Malti, J., Mountassif, D., & Amarouch, H. (2007). Antimicrobial activity of *Elettaria cardamomum*: Toxicity, biochemical and histological studies. Food chemistry, 104(4), 1560-1568.
4. Govindarajan, V. S., Narasimhan, S., Raghuveer, K. G., Lewis, Y. S., & Stahl, W. H. (1982). Cardamom—Production, technology, chemistry, and quality. Critical Reviews in Food Science & Nutrition, 16(3), 229-326.
5. Verma, S. K., Jain, V., & Katewa, S. S. (2009). Blood pressure lowering, fibrinolysis enhancing and antioxidant activities of cardamom (*Elettaria cardamomum*).

CARDAMOM

(Rs./k g.)

District	LG (Highest Price)	LG (Average Price)	LLG1 (Highest Price)	LLG1 (Average Price)	LLG2 (Highest Price)	LLG2 (Average Price)	LB (Highest Price)	LB (Average Price)	LNS (Highest Price)	LNS (Average Price)
Kandy	16,000.00	16,000.00	13,000.00	13,000.00	12,000.00	12,000.00	11,000.00	11,000.00	11,000.00	11,000.00
Matale	-	-	-	-	-	-	-	-	-	-
Nuwara_eliya	-	-	-	-	-	-	-	-	-	-
Kegalle	16,000.00	16,000.00	15,000.00	15,000.00	-	-	-	-	-	-
Ratnapura	-	-	-	-	-	-	-	-	-	-
Badulla	-	-	-	-	-	-	-	-	-	-
Kurunegala	12,000.00	11,500.00	11,000.00	10,500.00	-	-	-	-	-	-
Colombo	-	-	-	-	-	-	-	-	-	-
Gampaha	-	-	-	-	-	-	-	-	-	-
Kalutara	-	-	-	-	-	-	-	-	-	-
Galle	-	-	-	-	-	-	-	-	-	-
Matara	-	-	-	-	-	-	-	-	-	-
Hambantota	-	-	-	-	-	-	-	-	-	-
Monaragala	-	-	-	-	-	-	-	-	-	-
National	16,000.00	14,500.00	15,000.00	12,833.33	12,000.00	12,000.00	11,000.00	11,000.00	11,000.00	11,000.00

The chart given below gives the prices prevailing at present
http://exagri.info/mkt/2021/04.05.2021.html# cardamom

6. Korikanthimathm, V. S., Prasath, D., & Rao, G. (2000). Medicinal properties of cardamom *Elettaria cardamomum*. Journal of Medicinal and Aromatic Plant Sciences, 22, 683-685.
7. Nagashree, S., Archana, K. K., Srinivas, P., Srinivasan, K., & Sowbhagya, H. B. (2017). Anti–hypercholesterolemic influence of the spice cardamom (*Elettaria cardamomum*) in experimental rats. Journal of the Science of Food and Agriculture, 97(10), 3204-3210.
8. Nair, K. P. (2006). The agronomy and economy of Cardamom (*Elettaria cardamomum* M.): the "queen of spices". Advances in agronomy, 91, 179-471.
9. Rosengarten Jr, F. (1969). The book of spices. The Book of Spices.
10. Bernhard, R. A., Wijesekera, R. O. B., & Chichester, C. O. (1971). Terpenoids of cardamom oil and their comparative distribution among varieties. Phytochemistry, 10(1), 177-184.
11. Preedy, V. R. (Ed.). (2015). Essential oils in food preservation, flavor and safety. Academic Press.
12. Britannica, The Editors of Encyclopedia. "Cardamom". Encyclopedia Britannica, 12 Mar. 2020, https://www.britannica.com/plant/cardamom. Accessed 12 May 2021.
13. https://www.alibaba.com/product-detail/High-quality-Green-Cardamom-Elettaria-cardamomum_1700002176133.html
14. https://www.asiafarming.com/cardamom-cultivation
15. https://balconygardenweb.com/how-to-grow-cardamom-growing-cardamom-elaichi/
16. https://agro-market24.eu/uploads/photos/30297/sprzedam_vegetables-fresh-courgette_agro%20market24_gie%C5%82da%20rolna-326607-30297.png
17. https://www.firstpost.com/india/cardamom-cradle-longwa-village-in-nagaland-adopts-spice-farming-to-beat-drugs-terror-3425974.html
18. https://www.alamy.com/stock-photo-cardamom-pickers-and-grading-of-cardamom-near-thekkady-in-periyar-175916662.html
19. https://www.herbies.com.au/general/for-the-love-of cardamom/attachment/cardamom-grading/
20. https://www.malwattevalley.com/product/cardamom-powder-40g/
21. https://keralaspicesonline.com/product/green-cardamom-powder-100gm/
22. https://www.amazon.com/Spicy-World-Ground-Cardamom-Cardamon/dp/B000JMAVR6
23. http://www.sundaytimes.lk/210124/news/cardamom-scarcity-sees-prices-hit-the-ceiling-429911.html
24. https://newsbust.in/wpcontent/uploads/2020/10/pqb9o8d8_cardamomoil_625x300_06_October_20.jpg
25. https://www.saaraketha.com/products/cardamom-powder
26. https://www.thespruceeats.com/all-about-cardamom-995599
27. https://www.spicely.com/blogs/news/10341525-the-history-of-cardamom
28. https://www.indianmirror.com/ayurveda/indian-spices/cardamom.html
29. https://aromaticstudies.com/cardamom-queen-of-spices/

Being in control of your life and having realistic expectations about your day-to-day challenges are the keys to stress management, which is perhaps the most important ingredient to living a happy, healthy and rewarding life.

Marilu Henner

The medical literature tells us that the most effective ways to reduce the risk of heart disease, cancer, stroke, diabetes, Alzheimer's, and many more problems are through healthy diet and exercise. Our bodies have evolved to move, yet we now use the energy in oil instead of muscles to do our work.

David Suzuki

COMPARISON OF VITAMIN C (ASCORBIC ACID) CONTENTS AND ANTIOXIDANT ACTIVITIES OF FRESH AND DRIED *PHYLLANTHUS EMBLICA* FRUITS

By Shanika Mendis and Lakshmi Arambewela

Abstract

The Indian gooseberry (*Phyllanthus emblica* L.), known as Nelli in Sinhala is a native plant of Sri Lanka. *P. emblica* is an important household fruit, well known for its rich vitamin C content and effective antioxidant properties. The aim of this study was to compare ascorbic acid contents and antioxidant activities of fresh and dried *P. emblica* fruits. The ascorbic acid contents in fresh and differently dried *P. emblica* fruit samples from three different areas were quantitatively determined by a titrimetric method using Iodine. In fresh fruit samples, the total vitamin C content ranged from 0.4943 to 0.5341 g/100 g of edible portion. (2.2883 to 2.4458 g/100 g dry weight). In shade dried samples, the ascorbic acid content ranged from 0.5850 to 0.6164 g/100 g of dry weight. In sun dried samples, the total vitamin C content ranged from 0.5693 to 0.5999 g/100 g of dry weight while in oven dried samples it was from 0.1291 to 0.1409 g/100 g of dry weight. Both fresh and dry samples of *P. emblica* from Jaffna area showed the highest ascorbic acid content. Among differently dried samples, the shade dried *P. emblica* had the highest vitamin C content followed by sun dried and oven dried *P. emblica*. The antioxidant activities of fresh and dried *P. emblica* samples from Kottawa area were evaluated by DPPH scavenging assay as described by Navvaro et.al with some modifications. Ascorbic acid was used as the reference standard and IC50 value for ascorbic acid was 2.68±0.035 µg/mL. IC50 value of water extracts of fresh fruit was 10.00 ± 0.283 µg/mL. IC50 values of water extracts of shade dried, sun dried, and oven dried fruit samples were 12.01 ± 0.014 µg/mL, 13.20±0.283 µg/mL, and18.45±0.354 µg/mL, respectively. Fresh *P. emblica* samples exhibited stronger antioxidant activities compared to dried samples. Among dried samples, shade dried *P. emblica* had the highest antioxidant activity while the oven dried *P. emblica* exhibited the lowest antioxidant activity. The present study indicates that the fruit of *P. emblica* is a rich source of vitamin C and a potential source of natural antioxidants.

Phyllanthus emblica L. (Nelli) fresh fruits

General Introduction

The Indian gooseberry (*P. emblica*) is known as Nelli in Sinhala, and Indians call it Amla. *P. emblica* is known by a variety of names that vary within and from country to country.

Scientific classification of *P. emblica*

Kingdom	:	Plantae
Family	:	Phyllanthaceae
Genus	:	Phyllanthus
Species	:	*P. emblica*
		Phyllanthus emblica

Plant

P. emblica is a small to medium sized, much branched tree. The species is easy to cultivate, fire resistant, free of serious pests and diseases, grows relatively fast, provides higher returns even in marginal lands, and requires little care. It is popular as a backyard fruit tree species throughout in India and Sri Lanka whilst commercial orchards have been established in India. However, most of *P. emblica* fruits in today's trade in Sri Lanka are collected from forest areas. *P. emblica* is a deciduous species and trees are marginally leafless in the dry season, usually from January to March. In Sri Lanka, flowering period extends from October to December and fruits ripen from December to March.

Distribution

P. emblica is native to the tropics of South and Southeast Asia. At present, widely distributed in South Asia and to a limited extent in the American regions. (Simons et al., 2005). In Sri Lanka, *P. emblica* is naturally found in forests and plantations in dry and intermediate zones, and in many other regions as isolated trees in home gardens, roadsides, wastelands etc.

Description of *P. emblica* fruit

The fruit is nearly spherical, light greenish yellow, quite smooth, and hard on appearance. Fruits are pale green when tender, changing to light yellow or brick red (rarely) when mature. Fruit contains long, dark brown seeds.

Though all parts of a *P. emblica* tree are useful and yield a range of products, the main use is as a fresh or dried fruit. The fruit is important for consumers due to its high nutritive and therapeutic values. It contains five of the six tastes — sweet, sour, pungent, bitter, and astringent, all except salty.

The fruit is commonly consumed as a healthy food in both fresh and various preserved forms such as pickles, dried fruits, and beverage products. Fresh fruit is known as a rich source of vitamin C. (470-1810 mg/100 g pulp). It possesses the highest level of heat and storage stable vitamin C known to man. The Vitamin C in *P. emblica* has a special form that makes it easy for the human body to assimilate and is retained even if the fruit is dried or cooked. Recent clinical tests also show that it is more quickly assimilated into the body than the synthetic vitamin C.

Composition of *P. emblica* fruit

The fruit contains 30-50% of the pulp. The fruit pulp contains more than 80% of water. It also has protein, carbohydrate, fibre, minerals, and vitamins. It has a high density of tannins. The fruit also contains tannins and other polyphenols; trigalloglucose, terhebin, flavonoids, kaempferol, corilagen, ellagic acid and gallic acid. Tannins and polyphenolic compounds present in *P. emblica* fruits act as retardants of oxidation of vitamin C.

Constituent	Amount (per 100 g)
Energy (k cal)	58
Moisture (g)	81.2 (77-82)
Protein (g)	0.5
Fat (ether extract) (g)	0.1
Mineral matter (g)	0.7 (0.5-0.7)
Fiber (g)	3.4
Carbohydrate (g)	13.7 (14-21)
Calcium (Ca) (mg)	50 (12-50)
Phosphorus (P) (mg)	20 (20-26)
Iron (Fe) (mg)	1.2
Nicotinic acid (mg)	0.2
Thiamine (µg)	30
Vitamin C (mg)	600 (200-1,814)
Riboflavin (µg)	10
Vitamin A (µg)	4

Average composition of fruit pulp of *P. emblica*

Dried *P. emblica* fruit

When the fresh *P. emblica* fruit is dried, the main ingredient, water, is mostly eliminated, and the remaining constituents are present in considerably larger proportions. The dried fruit of *P. emblica* is used as a raw material in Ayurvedic medicine. It is a common constituent in various polyherbal preparations.

Dried *P. emblica* fruits

Uses of *P. emblic*a fruit

Food Uses

The mature fruits are edible and highly nutritive. Fresh fruits are eaten raw, or used in cooked food or prepared as pickle, sweetmeat and relishes. They are also made into jam, jelly, syrup, candy, chutney, dried chips, tablets, powder, preserve, cordial and juice. The processing of *P. emblica* into various forms is a useful value addition and preservation method. The presence of gallic and ellagic acid with glucose molecules present in the fruit prevents or retards the oxidation of vitamin C in the fresh fruit as well as in the dry form.

Medicinal Uses

The fruit is one of the three important ingredients of "Triphala", which is a popular Ayurvedic drug prepared with equal portions of Aralu, Bulu and Nelli. Triphala is routinely prescribed by Ayurvedic physicians for a number of diseases of the human body and is used in the combination of many of their stock preparations. *P. emblica* is used in various ayurvedic formulations. It may be used as a rejuvenative to promote longevity, and traditionally to enhance digestion, treat constipation , reduce fever, purify the blood, reduce cough, alleviate asthma, strengthen the heart, benefit the eyes, stimulate hair growth, and enliven the body.

Other Uses

P. emblica is a famous dye and tannin producing tree. The fruits are also used to produce a blackish grey colored dye. The dye is used to treat silk and wool and making black ink and hair dyes. Popularly used in inks, shampoos and hair oils, the high tannin content of Indian gooseberry fruit serves as a mordant for fixing dyes in fabrics. Amla shampoos and hair oil are traditionally believed to nourish the hair and scalp and prevent premature grey hair.

Vitamin C

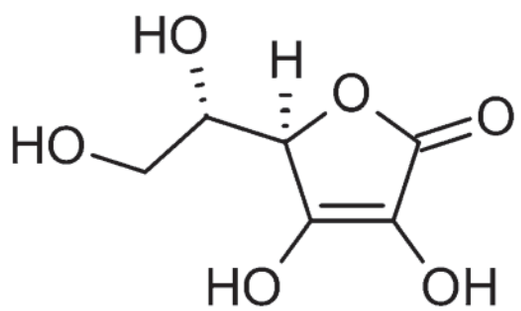
General Introduction

Vitamin C or L-ascorbic acid, or simply ascorbate, is an essential nutrient for humans and certain other animal species. Vitamin C refers to a number of vitamers that have vitamin C activity

in animals, including ascorbic acid and its salts, and some reduced forms of the molecule. Ascorbate and ascorbic acid are both naturally present in the body when either of these is introduced into cells since the forms interconvert according to pH.

Structure

Ascorbic acid resembles the sugar from which it is derived, being a ring containing many oxygen-containing functional groups.



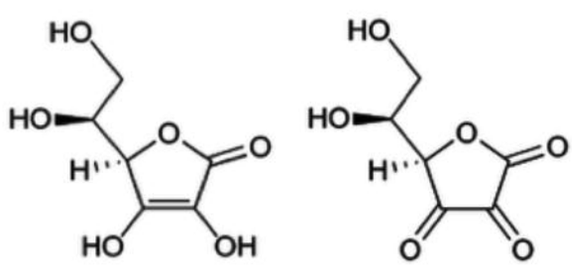
L-ascorbic acid

The name vitamin C always refers to the L-enantiomer of ascorbic acid and its oxidized forms. Chemically, there exists a opposite enantiomer D-ascorbic acid which does not occur in nature. It may be synthesized artificially. It has identical antioxidant properties to L-ascorbic acid yet has far less vitamin C activity (although not quite zero).The fact that the enantiomer D-ascorbate (not found in nature) has identical antioxidant activity to L-ascorbate, yet far less vitamin activity, underscores the fact that most of the function of L-ascorbate as a vitamin relies not on its antioxidant properties, but upon enzymic reactions that are stereospecific. The antioxidant properties of ascorbic acid are only a small part of its effective vitamin activity. "Ascorbate" without the letter for the enantiomeric form is always presumed to be the chemical L-ascorbate.

Basic chemistry

L-ascorbic acid is a white, odorless, crystalline compound, soluble in water, soluble in ethanol, but insoluble in fat solvents. It is readily oxidized to dehydroascorbic acid, the less biologically potent form. Ascorbic acid is very stable in acid solution because of the preservation of the lactone ring, but in alkaline solution hydrolysis occurs rapidly and vitamin activity is lost. It is very heat labile and prone to atmospheric oxidation, especially in the presence of copper, iron, or several other metallic catalysts. The reduced form is the most biologically active, but several derivatives or salts are obtainable which have varying degrees of ascorbate activity.

As a mild reducing agent, ascorbic acid degrades upon exposure to air, converting the oxygen to water. The redox reaction is accelerated by the presence of metal ions and light. It can be oxidized by one electron to a radical state or doubly oxidized to the stable form called dehydroascorbic acid.



Ascorbic acid (Reduced form) | Dehydroascorbic acid (oxidized form)

Structures of Ascorbic acid and DHAA

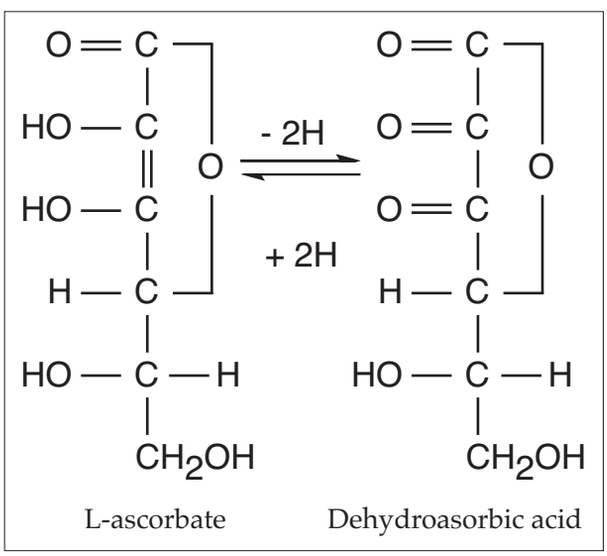
Ascorbic acid is unstable in aqueous solutions. This instability is due to its oxidation to dehydroascorbic acid, which is a reversible reaction, and subsequently to the irreversible formation of 2,3-diketogulonic acid.

Biological role

Ascorbic acid is a weak sugar acid structurally related to glucose. In biological systems, ascorbic acid can be found only at low pH, but in neutral solutions above pH 5 is predominantly found in the ionized form, ascorbate. All these molecules have vitamin C activity, therefore, and are used

synonymously with vitamin C, unless otherwise specified.

The biological role of ascorbate is to act as a reducing agent, donating electrons to various enzymatic and a few non-enzymatic reactions. The one- and two-electron oxidized forms of vitamin C, semidehydroascorbic acid and dehydroascorbic acid, respectively, can be reduced by the body by glutathione and NADPH-dependent enzymatic mechanisms. The presence of glutathione in cells and extracellular fluids helps maintain ascorbate in a reduced state.



Conversion of Ascorbic acid to DHAA

In humans, vitamin C is essential to a healthy diet as well as being a highly effective antioxidant Ascorbic acid performs numerous physiological functions in the human body.

It is an enzyme cofactor for the biosynthesis of many important biochemicals including collagen, carnitine, and neurotransmitters. It acts as an electron donor for important enzymes. During biosynthesis ascorbate acts as a reducing agent, donating electrons and preventing oxidation to keep iron and copper atoms in their reduced state. Ascorbic acid is synthesized in plants and some animals through a sequence of enzyme-driven steps, which convert monosaccharides to vitamin C. Humans depend on exogenous sources of the vitamin as they cannot synthesize it in the body. They require it in the diet.

Therapeutic Uses

Vitamin C helps the body in forming connective tissues, bones, teeth, blood vessels. Without this vitamin, the synthesized collagen is too unstable to perform its function. Vitamin C is essential to the development and maintenance of scar tissue, blood vessels, and cartilage.

It is widely used in the treatment of certain diseases such as common cold, anaemia, wound healing as well as infertility. The human body can store only a certain amount of vitamin C, so the body stores are depleted if fresh supplies are not consumed. Deficiency in this vitamin causes the disease scurvy in humans.

Vitamin C and Food

Vitamin C is available in a wide variety of natural products but is present in, significant quantities in vegetables and fruits. Plants rapidly synthesize L-ascorbic acid from carbohydrates and the variations occur in its content due to the different species of plants, ripeness, place of origin, storage conditions and handling.

Under an aerobic condition, ascorbic acid in foods is easily oxidized to form dehydroascorbic acid; both forms are likely to be present in equilibrium in foods. The vitamin C activity of ascorbic acid and its oxidized form, dehydroascorbic acid, is the same. In fresh foods the reduced form is the major one present, but cooking, processing and storage increase the proportions of the oxidized form.

Vitamin C chemically decomposes under certain conditions, many of which may occur during the cooking of food. Vitamin C concentrations in various food substances decrease with time in proportion to the temperature they are stored at and cooking can reduce the Vitamin C content of vegetables by around 60% possibly partly due to increased enzymatic destruction as it may be more significant at sub-boiling temperatures. Longer cooking times also add to this effect, as

will copper food vessels, which catalyses the decomposition.

Another cause of vitamin C being lost from food is leaching, where the water-soluble vitamin dissolves into the cooking water, which is later poured away and not consumed.

As ascorbic acid is susceptible to heat, it is difficult to retain it during the dehydration of foods. Therefore, ascorbic acid content is subjected to appreciable changes during the drying process.

The loss of ascorbic acid in food is dependent on many factors including the presence and type of heavy metals, such as copper and iron, light, pH, water activity level in the product, dissolved oxygen, and the drying temperature. The degradation of ascorbic acid can cause the quality loss and colour formation of food products.

Antioxidants

What are antioxidants?

An antioxidant is a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons or hydrogen from a substance to an oxidizing agent. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reactions.

Although oxidation reactions are crucial for life, they can also be damaging; plants and animals maintain complex systems of multiple types of antioxidants, such as glutathione, vitamin C, and vitamin E as well as enzymes such as catalase, superoxide dismutase and various peroxidases.

The main characteristic of an antioxidant is its ability to trap free radicals. Highly reactive free radicals and oxygen species are present in biological systems. These free radicals may oxidize nucleic acids, proteins, lipids, or DNA. It can cause damage or death to the cell. Antioxidant compounds scavenge free radicals and terminate the chain reactions by removing free radical intermediates, thus inhibiting the oxidative mechanisms that lead to diseases. They do this by being oxidized themselves, so antioxidants are often reducing agents such as thiols, ascorbic acid, or polyphenols.

When there are more free radicals (reactive oxygen species, ROS) in the human body than antioxidants, the condition is called oxidative stress, and has an impact on severe diseases. Antioxidants are widely used in dietary supplements and have been investigated for the prevention of diseases such as cancer, coronary heart disease. Antioxidants also have many industrial uses, such as preservatives in food and cosmetics and to prevent the degradation of rubber and gasoline.

Ascorbic acid as an antioxidant

Vitamin C plays a major role as an antioxidant that forms part of the body defense system acting as a reducing agent to reverse oxidation in liquids. It has been used in the pharmaceutical, chemical, cosmetic and food industry as an antioxidant.

It typically reacts with oxidants of the reactive oxygen species, such as the hydroxyl radical formed from hydrogen peroxide. Such radicals are damaging to animals and plants at the molecular level due to their possible interaction with nucleic acids, proteins, and lipids. Sometimes these radicals initiate chain reactions. Ascorbate can terminate these chain radical reactions by electron transfer. Ascorbic acid is special because it can transfer a single electron, owing to the stability of its own radical ion called "semidehydroascorbate", dehydroascorbate. The net reaction is:

$$RO\bullet + C_6H_7O_6^- \rightarrow ROH + C_6H_6O_6^{\bullet -}$$

The oxidized forms of ascorbate are relatively unreactive, and do not cause cellular damage. However, being a good electron donor, excess

ascorbate in the presence of free metal ions can not only promote but also initiate free radical reactions, thus making it a potentially dangerous pro-oxidative compound in certain metabolic contexts.

Materials and Methodology

Collection of samples

Three *P. emblica* samples (each weighing about 3 kg) were purchased from the markets in 3 different areas. (Maharagama, Kottawa, and Jaffna).

Preparation of samples

P. emblica fruits were cleaned, cut into small pieces and seeds were removed. From this, 1.5 kg portion was left for drying and the rest was used as the fresh sample.

Drying Methods

i. Shade drying

500 g of sample was spread on a newspaper and allowed to dry in the shade for 5 days.

ii. Sun drying

500 g of sample was spread on a newspaper and allowed to dry in the sunlight for 5 days.

iii. Oven drying

500 g of sample was kept in the oven at 60-65 ^{0}C for 28 hrs

The above-mentioned procedure was repeated for samples from three different areas.

Determination of moisture content

Fresh
A known quantity (4 g) from the fresh sample was placed on a watch glass and kept in the oven at 100-105 ^{0}C for 8 hrs until a constant weight obtained.

Dried
A known quantity (2 g) from the dried sample was placed on a watch glass and kept in the oven at 100-105 ^{0}C for 8 hrs until a constant weight was obtained.

The % moisture content was calculated by the following equation.

$$\% \text{ MC} = \frac{(\text{Wi} - \text{Wf})}{(\text{Wi} - \text{Wa})} \times 100\ \%$$

Wi – Initial weight of sample + watch glass
Wf – Final weight of sample + watch glass
Wa – Weight of the watch glass

Quantitative determination of the ascorbic acid contents in fresh and dried *P. emblica* fruits

Preparation of fresh *P. emblica* extract

Blended 25.00 g of fresh *P. emblica* sample with distilled water. Strained the pulp through a cheese cloth, washing it with water and collected all filtrate and washings into a 250 cm^3 volumetric flask. Made the extracted solution up to 250 mL with distilled water.

Preparation of dried *P. emblica* extracts

Blended 25.00 g of dried Nelli samples with distilled water. Strained the mixture through a cheese cloth, washing it with water and collected all filtrate and washings into a 250 cm^3 volumetric flask. Made the extracted solutions up to 250 mL with distilled water.

Preparation of 0.005 M I_2 solution

All the reagents and chemicals used were of analytical grade.

Dissolved 4.000 g of KI in a minimum amount of water and added 1.270 g of Iodine into the concentrated KI solution. The solution was shaken well until all the Iodine has been

dissolved. Allowed the solution to acquire room temperature and made up to 100.00 cm^3 mark. The above standardized 0.05 M I_2 solution was diluted 10 times to obtain the 0.005 M I_2 solution.

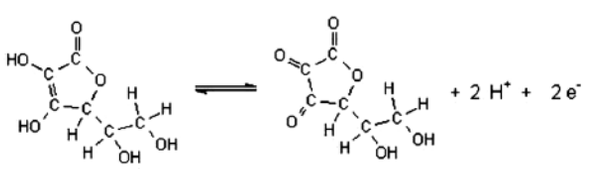
Titrimetric method

Pipetted out 25 mL portion from the prepared *P. emblica* extract into a stoppered glass bottle. Added 15 mL of chloroform (immiscible solvent) and starch solution and titrated with the 0.005 M I_2 solution. Continued the addition dropwise. Contents were shaken well after each addition. End point is marked by the first permanent trace of violet colour (the first sign of violet colour that remained after at least 20 seconds of swirling) due to the free I_2 in the chloroform layer. The titration was repeated to get three measurements that agree within 0.1 mL.

- The above redox titration is based on the following redox reaction.

Oxidation half reaction :

Ascorbate-DHAA standard redox couple is approximately 0.12 V



Ascorbic acid Dehydroascorbic acid

Reduction half reaction :

Standard cell potential is 0.5354 V

$$I_2 + 2e^- \longrightarrow 2I^-$$

Complete redox reaction :

$$C_6H_8O_6 + I_2 + H_2O \longrightarrow C_6H_6O_6 + 2I^- + 2H^+$$

Ascorbic acid Dehydroascorbic acid

I_2 : Ascorbic acid = 1:1

Calculation:

Take the end point resulted as y mL,

Vitamin C content per 100 g of *P. emblica* = 0.03522y

Take the moisture content as z%,

Vitamin C content per 100 g of dry weight $= \frac{0.03522y \times 100}{(100-z)}$

* Using the above method, ascorbic acid contents in all the samples (fresh and differently dried samples from 3 different areas) were determined. The results were analysed and compared.

Testing of radical scavenging activity employing DPPH method

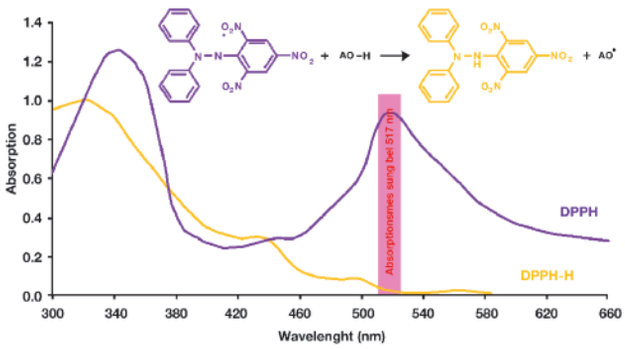
DPPH radical scavenging assay

The free radical scavenging activity of fresh and dried *P. emblica* extracts were determined by DPPH scavenging assay as described by Navarro et al (1993) with some modifications (Ordonez et al.,2006). It is based on the ability of 2,2-diphenyl-1-picrylhydrazyl (DPPH.), a stable free radical, to decolorize in the presence of antioxidants.

The DPPH test, which utilises a redox reaction with the 2,2-Diphenyl-1-picrylhydrazyl radical, can be used to determine the anti-oxidative capacity of extracts. The radical has a violet colour due to the unpaired nitrogen electron and, after reaction with the oxygen atom of a radical scavenger the reduced DPPH-H (2,2-Diphenyl-1-picrylhydrazin) is formed which is yellow. The colour change can be followed spectrophotometrically at 517nm and in this way the antioxidative potential of a substance or a plant extract can be determined.

$$(DPPH^{\bullet}) + (H\text{--}A) \longrightarrow DPPH - H + (A^{\bullet})$$

Purple Yellow



Reaction of DPPH (free radical) to DPPH (non-radical)

Preparation of concentration series of *P. emblica* extracts

In this assay, all *P. emblica* extracts were prepared in various known concentrations (2-24 µg/mL) in distilled water. They were placed in different test tubes and the volumes were made up to 1.5 mL by adding ethanol (96%). Volume of 3 mL of an ethanolic solution of DPPH (4 mg/100 mL in ethanol) was added to each of these tubes and shaken vigorously. The tubes were allowed to stand at room temperature for 5 min. and the absorbance was measured by spectrophotometer at the wavelength of 517 nm. Control tubes were prepared by adding ethanol instead of test solution. Ascorbic acid was chosen as the standard reference.

Concentration of *P. emblica* extract (µg/mL)	Amount of stock solution added (µL)	Amount of ethanol added (µL)	Amount of DPPH solution added (mL)
0 (control)	0	1500	3
2	90	1410	3
4	180	1320	3
6	270	1230	3
8	360	1140	3
12	540	960	3
16	720	780	3
24	1080	420	3

Preparation of concentration series of *P. emblica* extracts

Concentration of Ascorbic acid (µg/mL)	Amount of stock solution added (µL)	Amount of ethanol added (µL)	Amount of DPPH solution added (mL)
0 (control)	0	1500	3
0.5	45	1455	3
1.0	90	1410	3
1.5	135	1365	3
2.0	180	1320	3
2.5	225	1275	3
3.0	270	1230	3

Preparation of concentration series of Ascorbic acid

Preparation of DPPH solution

Weight of 4 mg of DPPH was dissolved in 100 mL of ethanol (96%).

Preparation of stock solutions of *P. emblica* extracts

Fresh

Blended 11.639 g of fresh *P. emblica* with distilled water. Strained the pulp through a cheese cloth, washing it with water and collected all filtrate and washings into a 250.00 cm^3 volumetric flask. Made the extracted solution up to 250.00 mL with distilled water to make the 10mg/mL (10000 µg/mL) solution of fresh *P. emblica*. The above solution was diluted 100 times to obtain the 100 µg/mL stock solution of fresh *P. emblica*.

Shade dried

Blended 0.282 g of shade dried powder with distilled water. Strained the pulp through a cheese cloth, washing it with water and collected all filtrate and washings into a 250.00 cm^3 volumetric flask. Made the extracted solution up to 250.00 mL with distilled water to make the 10

mg/mL (10000 µg/mL) solution of fresh *P. emblica*. The above solution was diluted 100 times to obtain the 100 µg/mL stock solution of shade dried *P. emblica*.

Sun dried

Blended 0.280 g of sun-dried powder with distilled water. Strained the pulp through a cheese cloth, washing it with water and collected all filtrate and washings into a 250.00 cm^3 volumetric flask. Made the extracted solution up to 250.00 mL with distilled water to make the 10 mg/mL (10000 µg/mL) solution of fresh *P. emblica*. The above solution was diluted 100 times to obtain the 100 µg/mL stock solution of sun-dried *P. emblica*.

Oven dried

Blended 0.269 g of oven dried powder with distilled water. Strained the pulp through a cheese cloth, washing it with water and collected all filtrate and washings into a 250.00 cm^3 volumetric flask. Made the extracted solution up to 250.00 mL with distilled water to make the 10 mg/mL (10000 µg/mL) solution of fresh *P. emblica*. The above solution was diluted 100 times to obtain the 100 µg/mL stock solution of oven dried *P. emblica*.

Preparation of stock solution of Ascorbic acid

Mass of 5 mg of ascorbic acid was dissolved in 100 mL of distilled water to obtain the 50 µg/mL stock solution of ascorbic acid.

Determination of % of radical scavenging activity (%RSA)

% Of radical scavenging activity (%RSA) was calculated using the following equation.

$$\% \text{ RSA} = [(A_0 - A_s) / A_0] \times 100$$

Ao - absorbance of the control

As - absorbance of the sample

- Inhibition curves were plotted and IC_{50} values were calculated. IC_{50} values denote the concentration of sample required to scavenge 50% DPPH free radicals.
- Using the above method, antioxidant activities of fresh and differently dried samples from Kottawa area, were determined.

Results

% Moisture contents

Area	Fresh	Dried		
		Shade Dried	Sun Dried	Oven Dried
Maharagama	78.40	11.20	10.50	6.80
Kottawa	78.52	11.36	10.80	6.90
Jaffna	78.25	11.15	10.47	6.68

Moisture contents of fresh and dried samples

Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence.

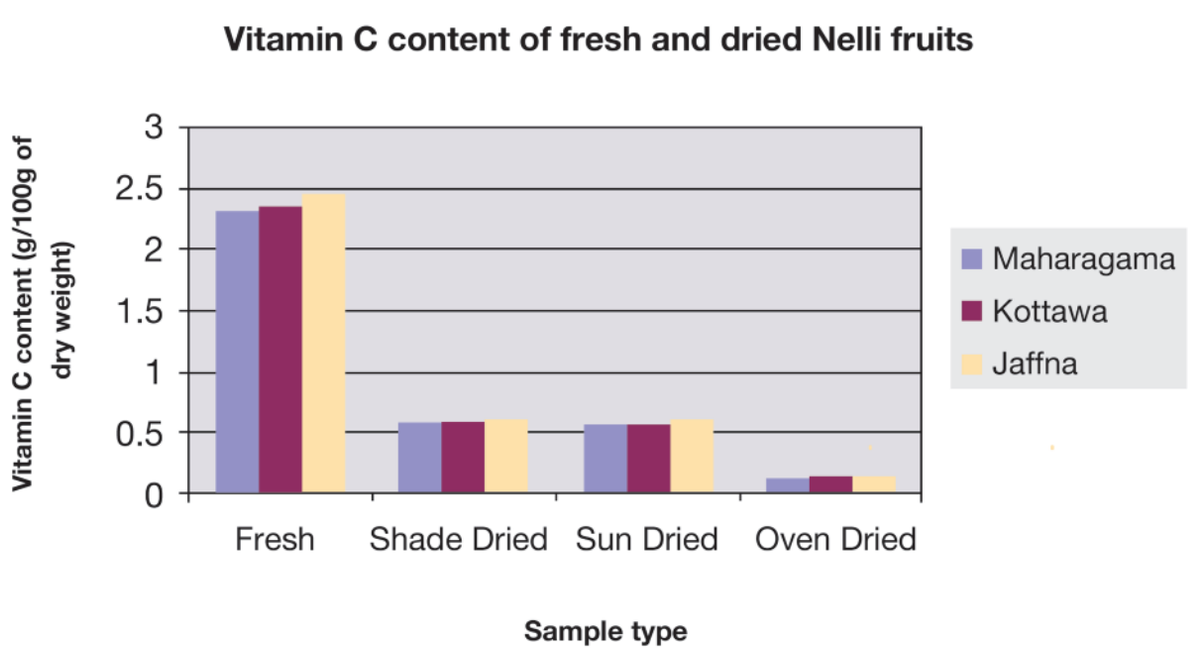
Louis Pasteur

Ascorbic acid Contents

Area	Fresh Vitamin C content		Dried Vitamin C content (g/100 g of dry weight)*		
	(g/100 g of edible portion)*	(g/100 g of dry weight)*	Shade Dried	Sun Dried	Oven Dried
Maharagama	0.4943 ±0.0020	2.2883 ±0.0094	0.5850 ±0.0020	0.5693 ±.0022	0.1291 ±0.0012
Kottawa	0.5019 ±0.0018	2.3364 ±0.0082	0.5947 ±0.0023	0.5766 ±0.0019	0.1324 ±0.0019
Jaffna	0.5341 ±0.0020	2.4458 ±0.0092	0.6164 ±0.0019	0.5999 ±0.0020	0.1409 ±0.0012

* Each value was expressed as the mean ± S.D of analysis done in triplicate.

Ascorbic acid contents of fresh and dried samples



Vitamin C contents of fresh and dried samples from three different areas

Absorbance at 517 nm

Concentration (µg/mL)	Absorbance at 517 nm	
	1st Analysis	2nd Analysis
0 (control)	0.618	0.623
90	0.588	0.584
180	0.539	0.532
270	0.456	0.447
360	0.371	0.365
540	0.254	0.248
720	0.178	0.169

Absorbances of fresh *P. emblica* extracts

Concentration (µg/mL)	Absorbance at 517 nm					
	Shade dried		Sun dried		Oven dried	
	1st Analysis	2nd Analysis	1st Analysis	2nd Analysis	1st Analysis	2nd Analysis
0 (control)	0.828	0.834	0.774	0.736	0.727	0.713
90	0.770	0.786	0.725	0.696	0.676	0.669
180	0.699	0.710	0.665	0.648	0.651	0.647
270	0.608	0.625	0.601	0.596	0.596	0.601
360	0.538	0.530	0.547	0.528	0.567	0.562
540	0.414	0.423	0.417	0.414	0.470	0.474
720	0.330	0.340	0.324	0.323	0.399	0.404
1080					0.292	0.303

Absorbances of dried *P. emblica* extracts

Concentration (µg/mL)	Absorbance at 517 nm	
	1st Analysis	2nd Analysis
0 (control)	0.717	0.734
45	0.666	0.695
90	0.619	0.650
135	0.546	0.572
180	0.475	0.496
225	0.386	0.405
270	0.292	0.309

Absorbance of reference standard (Ascorbic acid)

Concentration (µg/mL)	%RSA	
	1st Analysis	2nd Analysis
90	4.73	6.12
180	12.73	14.55
270	26.18	28.22
360	39.82	41.34
540	58.91	60.12
720	71.18	73.13

% Radical Scavenging Activity of fresh *P. emblica* extracts

Concentration (µg/mL)	% RSA					
	Shade dried		Sun dried		Oven dried	
	1st Analysis	2nd Analysis	1st Analysis	2nd Analysis	1st Analysis	2nd Analysis
90	7.00	5.72	6.33	5.43	7.01	6.12
180	15.58	14.81	14.01	11.96	10.45	9.23
270	26.57	25.04	22.44	19.02	17.83	15.71
360	35.02	36.43	29.37	28.26	22.01	21.14
540	50.00	49.22	46.16	43.74	35.35	35.50
720	60.14	59.21	58.04	56.11	45.12	43.33
1080					59.83	57.36

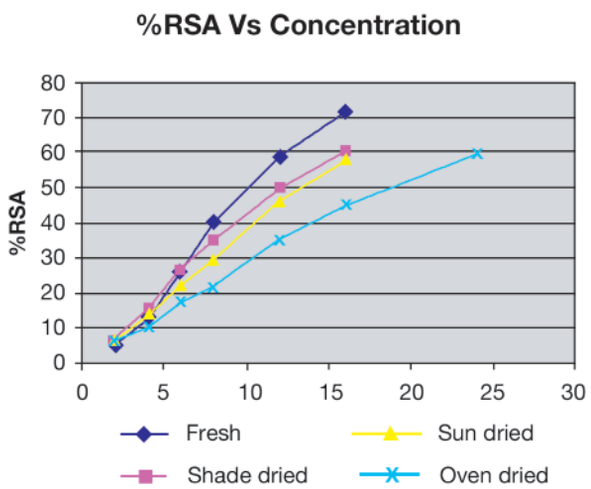
% Radical Scavenging Activity of dried *P. emblica* extracts

Concentration (µg/mL)	%RSA	
	1st Analysis	2nd Analysis
45	7.02	5.19
90	13.67	11.64
135	23.39	22.05
180	33.75	32.56
225	46.11	44.82
270	59.27	57.90

% RSA of reference standard (Ascorbic acid)

Curve of %RSA Vs Concentration

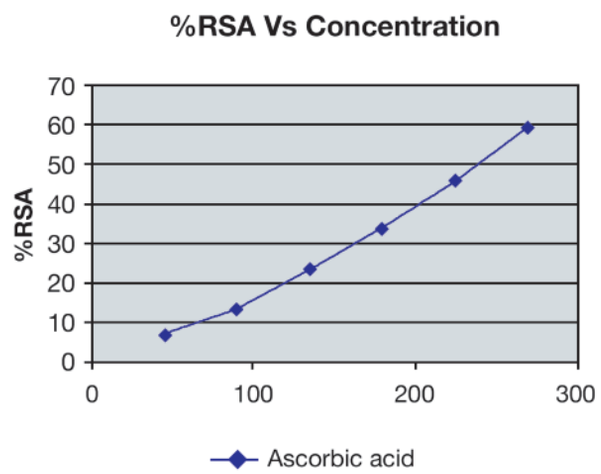
I. Fresh and dried *P. emblica* extracts



Concentration/microgram per millilitre

Curve of % RSA Vs Concentration of *P. emblica* extracts

II. Reference standard (Ascorbic acid)



Concentration/microgram per millilitre

Curve of % RSA Vs Concentration of Ascorbic acid

Discussion

Numerous analytical techniques have been reported in the literature for the determination of vitamin C content of food products. These include titrimetric, fluorometric, complexometric methods, electroanalytical techniques, liquid chromatography, high-performance liquid chromatography, spectrophotometric, and enzymatic. Most of these methods have their shortcomings, either they overestimate the level of vitamin C or underestimate it. Some are affected by other oxidizable species, some have poor detection limits, and some are too expensive to use and maintain. The instability of ascorbic acid in aqueous solution also leads to difficulties in quantifying it. The method commonly employed in these determinations was titrimetric.

In the present study, an attempt has been made to develop a simple and reproducible titrimetric method for quantitative determination of ascorbic acid.

Direct titration of the fresh and dried *P. emblica* extracts with I_2 solution and KIO_3 solution did not give successful results, because the *P. emblica* extracts were highly coloured. Identification of the end point in those titrations were significantly affected by the colouration of the sample solutions used. Especially the dried extracts had dark colours, and it was difficult to see any colour change in the solution to mark the end point. Although titrimetric determination of ascorbic acid using 2,6-DCPIP dye is the official method (AOAC Official Method 967.21 in AOAC, 2000)

IC_{50} values

Fresh *P. emblica* (µg/mL)*	Shade dried *P. emblica* (µg/mL)*	Sun dried *P. emblica* (µg/mL)*	Oven dried *P. emblica* (µg/mL)*	Ascorbic acid (µg/mL)*
10.00 ± 0.283	12.01 ± 0.014	13.20 ± 0.283	18.45 ± 0.354	2.68 ± 0.035

*Each value was expressed as the mean ± S.D of analysis done in duplicate

IC_{50} values determined from antioxidant assay

for the quantitative determination of ascorbic acid in vitamin preparations and juices, it could not be used here, because it is clearly stated that the method is not applicable to highly coloured samples. High Pressure Liquid Chromatography too can be used for quantitative estimation of ascorbic acids but is requires expensive machinery and high-quality solvents.

Thus, in this study, a few millilitres of an immiscible solvent (chloroform) were added to the sample solutions contained in glass reagent bottles and titrated with the I_2 solution. End point was marked by the first permanent trace of violet colour (the first sign of violet colour that remained after at least 20 seconds of swirling) due to the free I_2 in the chloroform layer. The colour of *P. emblica* extract is only present in the aqueous layer, so interferences did not occur at the detection of end point in the organic layer.

There may be drawbacks in this method also. There are naturally occurring substances in *P. emblica* fruits such as tannins, polyphenolic compounds, and minerals which can also get oxidized. But, as Iodine being a mild oxidizing agent, we can assume that it only oxidizes ascorbic acid. Loss of vitamin C can occur by chemical degradation during preparation step. Because of high solubility of Vitamin C in aqueous solution, there is potential for losses by leaching from freshly cut fruit. The loss can also occur during storage and handling. Ascorbic acid is susceptible to oxidation by atmospheric oxygen over time. For this reason, when the extracts were prepared, the analyses were done as soon as possible.

The dried fruit of *P. emblica* is most commonly used as a raw material in ayurvedic medicine and is a common constituent in various ayurvedic polyherbal formulations. *P. emblica* is a seasonal fruit and thus, drying is used as a preservation technique. However, there are concerns that there may be changes in vitamin C content during the drying process and the drying method adopted may affect the quality of dried fruit. Therefore , in the present study, ascorbic acid contents in fresh and differently dried *P. emblica* fruit samples from three different areas (Kottawa, Maharagama and Jaffna) were quantitatively determined.

According to the results presented in table 6, there is a significant difference in ascorbic acid contents between fresh and dried fruit samples. Thus, it is obvious that a significant loss of ascorbic acid occurs during the drying process. The loss in vitamin C content during drying involves oxidation and hydrolysis. Among differently dried samples, the shade dried *P. emblica* had the highest vitamin C content followed by sun dried and oven dried *P. emblica*. The rate of oxidation being high during oven drying, may be as a result of the effect of temperature, hence the oven dried samples showed the lowest amount of ascorbic acid. In both fresh and dried samples, *P. emblica* from Jaffna area had the highest ascorbic acid content. *P. emblica* fruits are also known as rich sources of antioxidants. In the present study, antioxidant activities of aqueous extracts of fresh and dried *P. emblica* samples from Kottawa area were evaluated by DPPH scavenging assay. According to the results presented in table 13, fresh *P. emblica* samples exhibited stronger antioxidant activities compared to dried samples. Among dried samples, shade dried *P. emblica* had the highest antioxidant activity while the oven dried *P. emblica* exhibited the lowest antioxidant activity. The antioxidant activities of all fresh and dried fruit samples were not higher than the chosen reference standard antioxidant, ascorbic acid.

Ascorbic acid present in *P. emblica* fruit alone does not account for all its antioxidant activities. Several other compounds like tannins, ellagic acid, gallic acid, and polyphenols present in *P. emblica* are also capable of scavenging free radicals.

An earlier study by Scartezzini et al. (2006) showed that the antioxidant activity of aqueous extract of processed fruit is due to ascorbic acid only to an extent of 60% or less.

P. emblica fruit has a wide range of domestic and industrial uses. However, it has been neglected in Sri Lanka and remains as an underutilized crop. Product diversification of *P. emblica* is taking place mainly due to its medicinal value. As a result, powder, capsules, tablets are common commercial items in the international market. Although the potential is high, this underutilized species has not reached the level of commercial exploitation in Sri Lanka. Only neglected wild trees are mainly exploited to meet the growing demand and a considerable amount is imported for Ayurvedic preparations.

Sri Lanka annually imports over 50000 kg of dried *P. emblica* spending almost million rupees. This is due to low production and lack of appropriate techniques to dry the fruits. Hence, it is of prime importance to increase extent of cultivation and develop techniques to dry the fruits up to quality standards as defined by the Ayurveda Department in Sri Lanka. Further, it is important to develop various value-added products such as food additives, cosmetics, Ayurvedic and herbal preparations.

P. emblica is not popular as a fresh fruit in Sri Lanka. Therefore, strategies are needed to enhance the utilization of *P. emblica*. It is necessary to make the community aware of the nutritive and medicinal values of *P. emblica* to improve the level of consumption and thereby increase the demand within the local markets.

Conclusion

The present study implies that the fruit of *P. emblica* is a rich source of vitamin C and a potential source of natural antioxidants.

There is a significant difference in ascorbic acid contents between fresh and dried *P. emblica* fruit samples. Thus, it is obvious that a significant loss of ascorbic acid occurs during the drying process. Also, there is a major difference in antioxidant activities of fresh and dried *P. emblica* fruit samples. Hence, a reduction of antioxidant property occurs during the drying.

Both ascorbic acid content and antioxidant activity varied with type of drying method used. Thus, it's obvious that the drying method adopted may affect the quality of dried fruit. Among dried samples, shade dried *P. emblica* had the highest ascorbic acid content while the oven dried *P. emblica* had the lowest ascorbic acid content. Similarly shade dried *P. emblica* exhibited the highest antioxidant activity while the oven dried *P. emblica* exhibited the lowest antioxidant activity. Hence, nutritional, and medicinal properties are highly retained in shade dried and sun-dried samples compared to oven dried sample. Therefore, when preparing value added products using dried *P. emblica*, especially the Ayurvedic and herbal formulations, it is appropriate to employ shade drying and sun drying techniques.

References

1. Wealth of India - Raw materials. Council of Scientific Industrial Research- New Delhi -Vol.3, D-E p.168-170 (1952)
2. W.W.P.N.-Geekiyanage (2009), *Phyllanthus emblica* L. Industrial Technology Institute - Sri Lanka p.25.
3. Compendium of Medicinal Plants (A Sri Lankan Study) - Ayurveda Department of Sri Lanka Vol.2, p.180-185 (2002)
4. D.K.N.G. Pushpakumara,; H.M.S- Heenkenda (2007) Nelli (Amla) *Phyllanthus emblica* L chapter 6, (Source: In: Pushpakumara, D.K.N.G., Gunasena, H.P.M. and Singh, V.P. 2007 (eds) Underutilized fruit trees in Sri Lanka. p. 180-221. World Agroforestry Centre, South Asia Office, New Delhi, India)
5. E.R, Jansz, S.T.C Mahavithanage (1997) Vitamin C - Have all its mysteries been unravelled? Institute of Chemistry Ceylon p.5-20
6. British Pharmacopoeia (BP) (2003) - Vol.1, p.778
7. United States Pharmacopoeia (USP) (1993) - Vol.1, p.55
8. Jeffrey G.H., Basset J., Mendhan J., Denny, R.C.; "Vogel's Textbook of Quantitative Inorganic Analysis" Fifth Edition ELBS; Longman p.373-386
9. L.W .Doner, -Analysis of Ascorbic acid and related compounds in fluids and tissues (1984), Trace analysis Vol.3 p.113-123.

10. W. Okiei, M. Ogunlesi, L. Azeez, V. Obakachi, M. Osunsanmi, G. Nkenchor (2009) - The voltametric and titrimetric determination of ascorbic acid levels in tropical fruit samplesInt. J. Electrochem. Sci., 4 Int. J. Electrochem. Sci., 4 276 -287
11. L. A. Azeez, O. Uthman, K.T. Majolagbe (2010) - Statistical Evaluation of Titrimetric Method Using N-Bromosuccinimide (Nbs) and Cyclic Voltammetry for the Assessment of Ascorbic Acid Level in Vegetables and Tuber Products International Journal of Pharmaceutical & Biological Archives; 1(1): 44 – 50
12. M. Aminuddin, F. Hussain, K. Mehmood - (2003) Statistical Evaluation of the N- Bromosuccinimide and Iodine as Titrimetric Methods for Estimation of Vitamin C in Orange Juice and Pharmaceutical Preparations –Pakistan Journal of Pharmaceutical Sciences.Vol. 16, No.2, , pp.69-76
13. P. Mishra, V. Srivastava, D. Verma, O.P Chauhan, G.K.Rai: (2009) Physico-chemical properties of Chakiya variety of Amla (*Emblica officinalis*) and effect of different dehydration methods on quality of powder-African Journal of Food Science - Vol.3(10) pp.303-306
14. S. Thankitsunthorn, C. Thaworphiphatdit, N. Laohaprasit, G. Srzednicki, (2009) - Effects of drying temperature on quality of dried Indian Gooseberry powder- International Food Research Journal 16; 355-361
15. J.Charoenteerabon, C. Ngamkitidechakul, N.Soonthornchareonnon, K. Jaijoy, S. Sireeratawong, (2010) – Antioxidant activities of the standardized water extract from fruit of *Phyllanthus emblica* Linn.- Songklanakarin J. Sci. Technol. 32(6),599-604
16. V. Shukla, M.Vashihta, S.N.Singh- Evaluation of antioxidant profile and activity of Amalaki (*Emblica officinalis*), (2009) Spirulina and Wheat Grass -Indian Journal of Clinical Biochemistry, 24 (1) 70-75
17. http://chemistry.about.com/od/demonstration-sexperiments/ss/vitctitration.html
18. http://www.chemteach.ac.nz/investigations/documents/vitaminc_iodate.pdf
19. http://wwwchem.csustan.edu/chem1112/1112vitc.html
20. http://en.wikipedia.org/wiki/Phyllanthus_emblica
21. http://www.worldagroforestry.org/downloads/publications/PDFs/BC07317.PDF
22. http://en.wikipedia.org/wiki/Ascorbic_acid
23. http://en.wikipedia.org/wiki/Vitamin_C
24. http://en.wikipedia.org/wiki/Antioxidant
25. http://www.medallionlabs.com/Downloads/Antiox_acti_.pdf

Democracy

Democracy is not just an electoral ritual, but the power of people to shape their destiny, determine how natural resources are owned and utilized, how food , water and energy are distributed, and how children are educated.

Vardane Shiva

The good earth is dying; so in the acme of humanity let us move. Let us make our hard but necessary decisions, let us do it quickly. Let us do it now.

Isaac Asimov

Technology and Civilization

The rise of the middle classes, the growth of commerce, industry, education and many other features of modern civilization may be traced back to the agricultural revolutions -technological but not scientific - of nine to ten centuries

John Lenihan

PRODUCTS FROM LINK NATURAL

LINK SUDANTHA: ENSURING TEETH FOR LIFE

By Tashika Fernandopulle

Link Natural Sudantha

A beautiful smile is aesthetically pleasing. Lying behind those lips are the colloquial *pearly whites* that gives way to a healthy life. Imagine a gummy smile devoid of teeth, imagine the face that holds that smile: drawn, misshapen and aesthetically unpleasing. Add to that the psychosocial impact of bullying due to incorrect pronunciation and improper verbalization; sufficient grounds to be shunned from society.

With emphasis on other organs in the human body, teeth take a backseat where health is concerned. Yearning for a beautiful smile sets the tone for oral care. However, the gravity of oral care in the context of health and wellbeing is poorly understood by people. Tooth ache, dental caries, bleeding gums, harmful breath, tooth sensitivity: hearing these very words is enough for one to cringe. Children are taught good oral hygiene practices, only to believe that losing teeth as one ages is normal. This sad, mythical reality has been ingrained in the mass' mind with a strong refusal to seek the truth.

Teeth : The Beginning and the End

Teeth are an essential to life, contributing to a better quality of life. In the absence of teeth, the quality of one's life takes a downward spiral. While life giving oxygen and nutrition keeps one alive, teeth ensures one's continuity through the facilitation of nutrition. Ingested food travels across a complex network of organs, beginning with the buccal cavity. Initial stages of digestion occur here, where the chewing action and mechanical grinding of food by teeth begins the process of digestion in combination with salivary enzymes. In an instance where teeth are absent in the buccal cavity, the initial stage of digestion is hampered leading to a delay in nutrient absorption via subsequent digestive processes.

Sadly, teeth are an underrated organ of the body (Sartaj & Sharpe, 2006).

With emphasis on debilitating disease conditions racking body and mind, teeth are a forgotten

entity of concern. As such, the mere act of brushing one's teeth twice a day is often neglected. Implications of staying away from such good habits are plentiful: bad breath (halitosis), dental caries, calculi formation and gingival disorders.

Thus, resulting in the loss of teeth, leading to dysfunctions in digestion and associated health complications, change in physical appearance (figure 1) and speech. This irrevocable change could be mediated with prosthetic devices and cosmetic intervention. But, at what cost? A sustainable remedial sustainable solution is imperative.

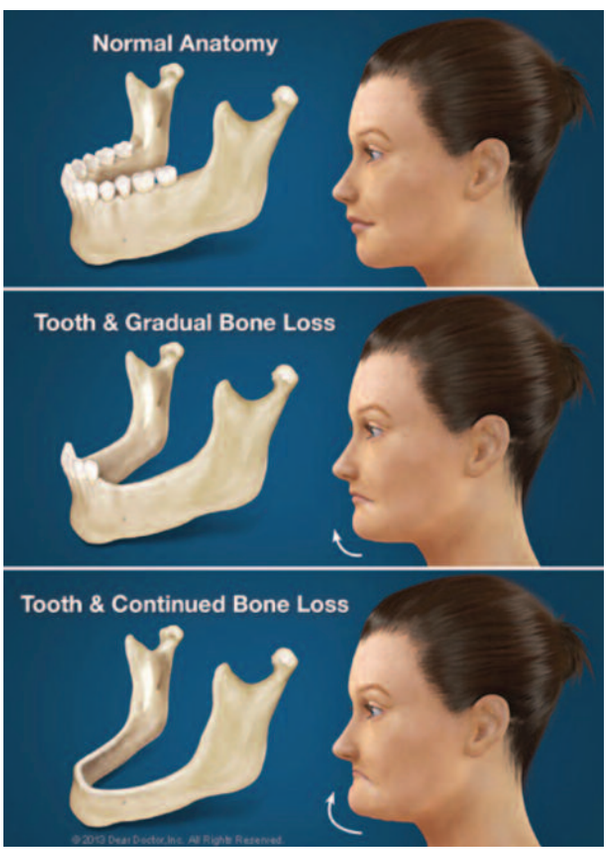


Fig. 1: Change in Physical Appearance Due to Tooth Loss

Facing Facts

According to the National Oral Health survey of 2015/2016, published by the Ministry of Health Nutrition and Indigenous Medicine (in 2018):

- >40% of children (5-15 years) cleaned their teeth only once daily
- >21% of adults (35-44 years) cleaned their teeth only once daily
- >33% of adults (65-74 years) cleaned their teeth only once daily
- 70% of adults (65-74 years) use brushes to clean their teeth
- >75% of the population use a fluoridated toothpaste

These staggering statistics are indicative of a serious oral health issue in the country. Although more than 75% of the local population clean their teeth (assumption: with and without toothbrushes), the incidence of oral health problems is on the rise:

Oral health statistics in SL (according to the National Oral Health Survey 2015/2016) :

Oral Health Problem	Age Group (Yrs)	Proportion (%)
Calculus (tartar)	5 12 15 35-44 65-74	13.7 47 49 70.7 71.6
Gingival bleeding-on-probing	5 12 15 35-44 65-74	17.1 34.9 34.3 37 36.2
Periodontal pockets (spaces or openings surrounding the teeth under the gum line)	15 35-44 65-74	5.4 25.3 44.4
Total caries (decayed, missing, filled teeth were > 0)	5 12 15 35-44 65-74	63.1 30.4 41.5 92.5 98.3

Therefore, it can be inferred that the usage of some toothpaste formulations by the population needs serious re-evaluating. If more than 75% of the population used a fluoridated toothpaste, and if fluoridated toothpastes contributed to preventing oral health issues; the statistics obtained from the National Oral Health Survey should indicate lower incidence of oral health problems. The question of whether fluoridated toothpastes are efficacious in curbing oral health problems is therefore pondered.

The Root Cause

Looking at the high prevalence of oral health problems in Sri Lanka, the actual origin of such problems is examined. The oral microbiome consists of a symbiotic relationship between *good* and *harmful* bacteria. This ecosystem is essential for the sustenance of good oral health. However, imbalance of microbial flora contributes to oral diseases such as dental caries, periodontitis, and gingivitis. (figure 2 – 4).

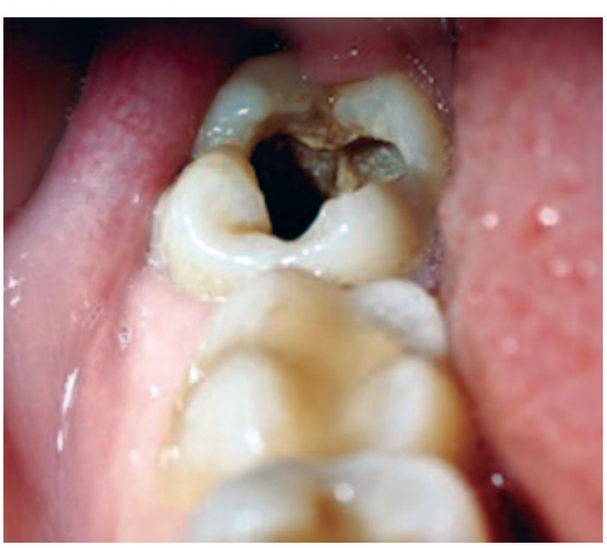


Fig .2: Dental Caries

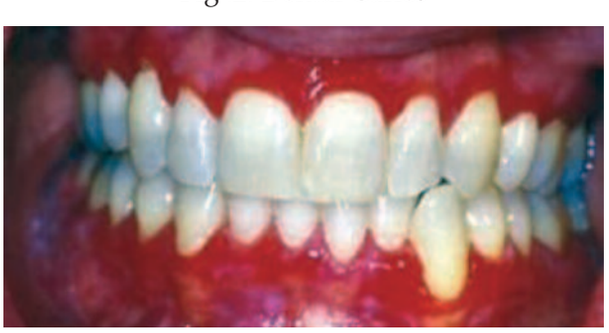


Fig .3: Gingivitis

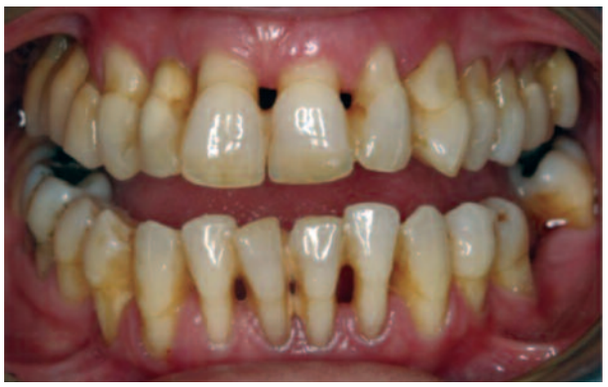


Fig .4: Periodontitis

The oral cavity harbours a diverse microbiota, with over 700 species of microorganisms ranging from bacteria, fungi, protozoa and viruses. The mouth acts as a complex habitat where microorganisms colonize the hard surfaces of teeth and the soft oral mucosa tissues. The oral microbiome is crucial for maintaining oral and systemic health; it also includes pathogenic anaerobic bacteria. Some of these common pathogens are: *Streptococcus mutans*, *Porphyromonas* spp. and *Treponema denticola.* which are responsible for dental caries and gum disease.

Poor oral health can have detrimental consequences for our general and oral health. On a health perspective, one's mouth is the key entry point to the rest of one's body. A disruption to imbalance the finely tuned homeostasis of oral microbiome can have detrimental consequences for our general and oral health allowing disease-promoting bacteria in oral cavity to manifest to cause inflammation of the gingiva and transferred to distant parts of the body through the blood stream. (figure 5).

Although the body has its many defense mechanisms against pathogens, poor oral health is seen to be associated with several disease conditions: diabetes, heart diseases (bacterial endocarditis), depression, oral cancer and adverse pregnancy outcomes to name a few.

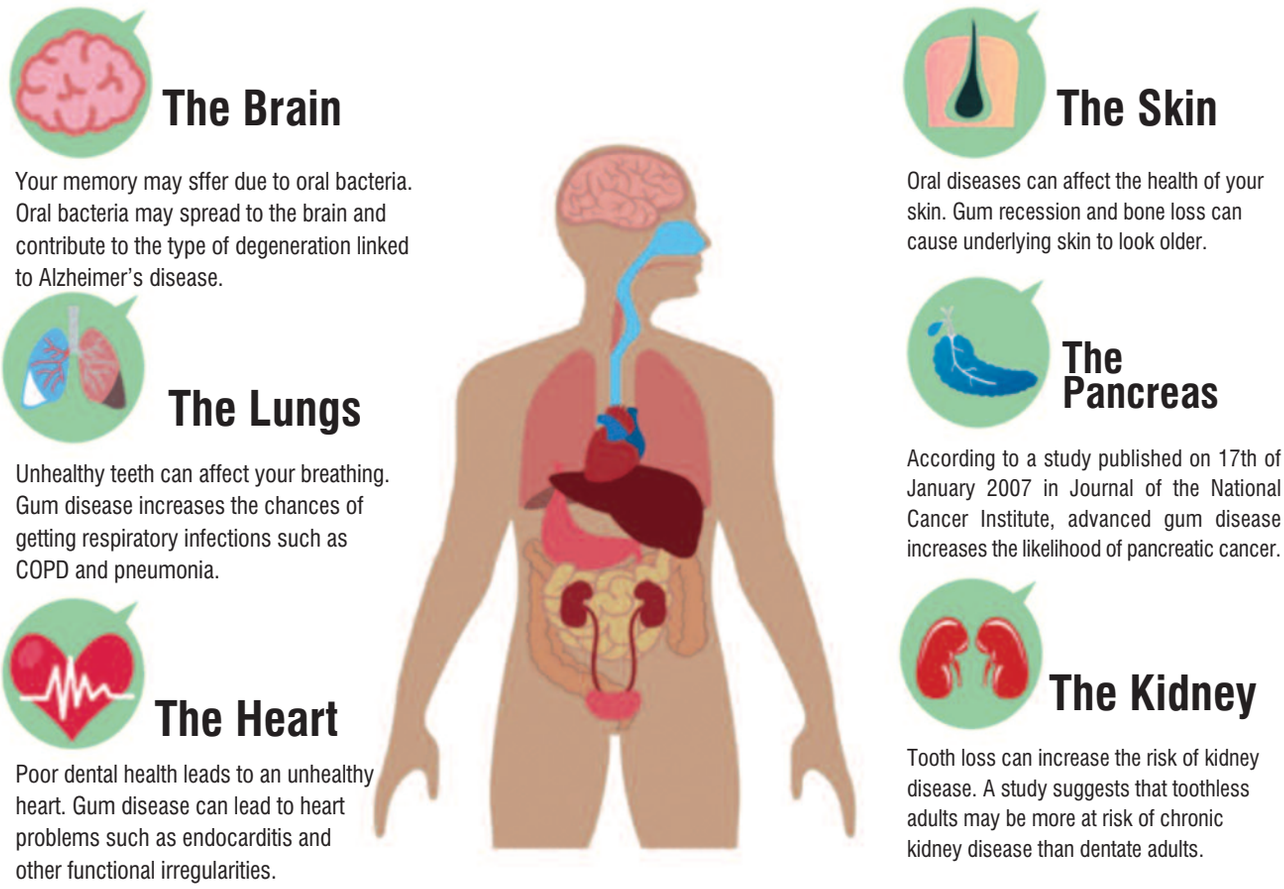


Fig. 5: Impact of Poor Oral Health on Overall Health

A recent study indicated that *Porphyromonas gingivalis*, found in the oral cavity, can cause Alzheimer's disease (Beydoun, et. al., 2020). In another aspect, persons with specific conditions, such as diabetes, are more susceptible to suffer from periodontal diseases.

The Solution

Targeting the root cause of the problem: harmful bacteria, proves effective in preventing the incidence of ill effects as previously described. A total oral care solution targeting the root cause of these segments would keep harmful bacteria

Fig .6: Link Sudantha, The Total Oral Care Expert

l action at bay. Link Sudantha (figure 6), the only clinically proven and scientifically validated total oral care expert, inhibits the growth of harmful anerobic bacteria within the oral cavity, thus preventing dental caries and gum diseases.

Sudantha: Provides Total Oral Care

The nine plant extracts incorporated scientifically into Link Sudantha stems from centuries of ayurvedic expertise and has been proven to promote oral hygiene as well as relief from oral health problems. A unique blend of Rathkihiriya (*Acacia chundra* Willd.) Adathoda (*Adhatoda vasica* Nees.), Moonamal (*Mimusops elengi* L.), Black pepper (*Piper nigrum* L.), Karanda (*Pongamia pinnata* (L.), Pirerre) Masakka (*Quercus infectoria* Olivier.), Clove (*Syzygium aromaticum* L.), Aralu (*Terminalia chebula* Retz.) and Ginger (*Zingiber officinale* Roscoe) tell of time-tested herbal ingredients for total oral care.

These extracts act synergistically to effectively prevent dental plaque, prevent gum disease, prevent dental caries, harmful breath (of oral origin) and tooth sensitivity. Consistent usage of Link Sudantha also decreases gingival bleeding and salivary anaerobic bacterial count (*S. mutans*), actively reduces plaque and gingivitis, modulates epithelial cell IL-8 expression: a key host defense component in oral health and disease and contributes to the maintenance of oral health through the inhibition of *S. mutans* biofilm formation.

Two clinical studies, both conducted locally, and two in-vitro studies conducted overseas have proven the efficacy of Link Sudantha on several aspects, in summary:

- Jayashankar, S. et. al., (2011) evaluated the effects of a herbal toothpaste (Sudantha) on gingival bleeding, oral hygiene and microbial variables. The study's findings indicated a significant reduction of plaque formation, gingival bleeding and the salivary anaerobic bacterial counts.

- Howshigan, J. et. al., (2016) tested the effects of an ayurvedic medicinal toothpaste (Sudantha) on clinical, microbial and oral hygiene of patients with chronic gingivitis. This study proved, with robust evidence, the benefits of Sudantha in antiplaque and antigingivitic effects in the test group.

- Chang, A. et. al., (2020) scientifically proved that the ayurvedic herbal extracts of Sudantha inhibits oral epithelial cells IL-8 responses to host and bacterial agonists. In humans, gingival keratinocytes expresses IL-8, which is a key inflammatory mediator for neutrophil activation, tissue remodeling and angiogenesis. In episodes of periodontitis and gingivitis, modulation of IL-8 by gingival keratinocytes, is essential for good oral health.

- Rajapakse, S. et. al., (2020) analyzed the ability of the herbal extracts in Sudantha to arrest *S. mutans* biofilm formation in vitro. It was concluded that the herbal extracts in Sudantha contributed to the maintenance of good oral health through the inhibition of *S. mutans* biofilm formation. Hence its efficacy in preventing dental caries and periodontal diseases by its potency in countering biofilm associated oral diseases.

The efficacy of Link Sudantha is unparalleled to other toothpaste brands in the market in terms of its ability to arrest the root cause of oral health problems. Link Sudantha, is the only toothpaste in Sri Lanka clinically proven at the Department of Oral Medicine and Periodontology, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka and scientifically validated at the Department of Periodontics and Oral Health Sciences, University of Washington School of Dentistry, Seattle, USA., to arrest the root cause of oral health diseases. A breakthrough in modern research and development, amalgamating age-old ayurvedic wisdom with modern science and technology, ensures total oral care as also endorsed by Link Sudantha's loyal

customer base. From its nine herbal constituents to its pleasant aftertaste and lasting freshness, Link Sudantha can capture the trust and confidence of people as a total oral care expert for generations to come.

A healthy smile will last a lifetime with Sudantha.

Reference

1. Sartaj, R., & Sharpe, P. (2006). Biological tooth replacement. Journal of anatomy, 209(4)

2. Jayashankar, S., Panagoda, G., Amaratunga, E., Perera, K. and Rajapakse, P. (2011). A Randomised Double-Blind Placebo-Controlled Study on The Effects of an Herbal Toothpaste on Gingival Bleeding, Oral Hygiene and Microbial Variables. *Ceylon Medical Journal*, 56(1).

3. Howshigan, J., Perera, K., Samita, S. and Rajapakse, P. (2016). The Effects of an Ayurvedic Medicinal Toothpaste on Clinical, Microbiological and Oral Hygiene Parameters in Patients with Chronic Gingivitis: A Double-Blind, Randomised, Placebo-Controlled, Parallel Allocation Clinical Trial. *Ceylon Medical Journal*, 60(4).

4. Chang, A., Bamashmous, S., Darveau, R. and Rajapakse, S., (2020) . An Ayurvedic herbal extract inhibits oral epithelial cell IL-8 responses to host and bacterial agonists. BMC Complementary Medicine and Therapies, 20(1).

5. Rajapakse, S., Giardino, M. A., Kulasekara, H. D., Darveau, R. P., & Chang, A. M. (2020). An Ayurvedic Herbal Extract Inhibits *Streptococcus mutans* Biofilm Formation and Disrupts Preformed Biofilms *in vitro*. *Journal of Traditional Medicine & Clinical Naturopathy*, 9(4).

6. Beydoun, M. A., Beydoun, H. A., Hossain, S., El-Hajj, Z. W., Weiss, J., & Zonderman, A. B. (2020). Clinical and Bacterial Markers of Periodontitis and Their Association with Incident All-Cause and Alzheimer's Disease Dementia in a Large National Survey. *Journal of Alzheimer's Disease*, 75(1)

Inaction

There are costs and risks to a programme of action, but they are far less than the long-range risks and costs of comfortable inaction.

John F Kennedy

"The conservation of nature, the proper care for the human environment and a general concern for the long-term future of the whole of our planet are absolutely vital if future generations are to have a chance to enjoy their existence on this earth."

— Prince Philip

"Suppressing the anger is when you turn your energies and thoughts to something else, usually something more positive and more constructive. However, anger needs to be expressed and holding in it can turn it on you and cause health problems, such as expression, and hypertension, hypertension, which can also lead to an increased risk of a heart attack."

James Seals, Anger

"LINKING" WITH PEOPLE AND SOCIETY

THE GLOBAL ROLE OF LINK NATURAL PRODUCTS (PVT) LTD FOR SUSTAINABLE DEVELOPMENT IN "LIFE ON LAND".

By Madushan Bandara and Priyantha Collonnege

It has been estimated that plant life provides 80 percent of the human diet and forests cover 30 percent of the Earth's surface, providing vital habitats for millions of species. By the end of the 18th century ,the number of species identified was around 1 million, and taxonomic research carried out in the 250 years after Linnaeus, the number of species discovered and identified stands at around 1.8 million, with estimates of around 5-30 million species more to be discovered. However, as highlighted in the editorial, destruction of forest cover is rampant causing untold harm to the environment and existing ecosystems. In 2020, a net loss of nearly 100 million ha of the world's forests has been estimated. As reported in the IUCN Red Book in 2020 globally, the species extinction risk has worsened by about 10 per cent over the past three decades.

This issue was identified as been of vital importance by the United Nations Conference on Sustainable Development and after much discussion produced seventeen sustainable development goals (SDG 17) to protect the earth at the Rio de Janeiro summit in 2012.

Link Natural Products (Pvt) Ltd, is a world class manufacturer and supplier of highest quality Ayurvedic pharmaceuticals, Herbal health care products, Herbal cosmetics, Essential oils, and Oleoresins. More than 260 products are produced by them, and in keeping with the company vision, pure natural herbs are used as raw materials. The wild harvest provides some of the necessary raw materials for manufacturing. To fulfill the goals set by the SDG, the company focuses on obtaining its plants from the forest while ensuring its protection, initiating a sustainable development programme called SARAOSU. This programme is implemented by Link Natural Products (Pvt) Ltd with the help of the Forest Conservation Department in Sri Lanka. There are four main objectives in Saraosu project.

- Implementing a sustainable cultivation programme around the Nilgala forest, along with the Forest Conservation Department.
- Enhancing the social and economic status of people who live near Nilgala forest, specially the Vedda community, by developing as legal and quality suppliers.
- Building a sustainable network for receiving the quality herbals which are essential for the production process, through legal mean.
- Saving foreign exchange by supplying natural herbs within Sri Lanka itself without importing.

Planting programme

Various activities are conducted by the company, for achieving the objectives. Long term plant cultivation programmes (such as Nelli (*Phyllanthus emblica* L.), Bulu (*Terminalia bellirica* (Gaertn.) Roxb.), Karanda (*Pongamia pinnata* (L.) Merr.), Mee (*Madhuca longifolia* (L.) J.F.Macbr. etc.) are carried out for the purpose of conservation of the Nilgala forest. Another aspect looked into is Awareness. People must be educated about the importance of trees and forests, and for this purpose, awareness programmes will be conducted with the hope of changing the attitude of the people. These will be based on both adults and school children, Trafficking and poaching of protected species will be wound up through this activity. Natural habitats and genetic resources will be protected and conserved. As an example, uneducated people accumulate Aralu (*Terminalia chebula* Retz.), by cutting down trees. The Agriculture department of Link Natural Products demonstrate the correct techniques used at the harvesting process. A raw material collection center will also be established near the Nilgala forest by the Forest Conservation Department and all activities will be supervised by them.

Thus, with this programme, in addition to obtaining raw material for its products, the company hopes to inculcate an awareness of the importance of trees and forests among both adults and school children and create a better understanding between the people and the Forest Conservation Officers as well via the legal background. This will help to end trafficking.

When considering the communities living near the forest, the company hopes to increase their social and economic condition by providing money directly to the farmers and reducing the intermediary costs. The Nilgala forest too will be protected.

Finally Link Natural Products (Pvt) Ltd is happy to be able to contribute to SDG in Sri Lanka through the fifteenth goal which is "Life on Land" for sustainable development in Sri Lanka, while providing a continuous supply chain of good and quality raw materials within Sri Lanka itself and producing high quality products to the local and international customers.

Group awareness programme - Saraosu project

Nature

Our goal must be to preserve nature so that future generations could explore its glory and witness the magic that is our world

Ansel Adams (1902-1985)

The philosophers say that nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity and affects not the cause of superfluous causes

Isaac Newton

Wars

Wars of this century have fought for oil, Wars of the next century will fight for water.

Theodore W Shultz

We cannot survive as a species if greed is privileged and protected and the economics of the greedy set the rules for how we live and die

Vanda Shiva

Aging is a natural part of life and brings many changes to and for each of us. Many of these changes happen gradually over time and may go unnoticed until they reach a certain point where we become aware of them and can no longer deny them.

Nina W. Brown,
Children of the Aging Self-Absorbed

Science and Wisdom

We are not a superior species because we can make weapons to kill, but because we are permitted the luxury of science. It is wisdom we lack when we use it to wage war.

John Lenihan

AVAILABILITY OF LINK PRODUCTS

Editor's Note : A frequently asked question by Link afficionados, 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	Phamacy	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 Akalapalitha	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
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														✓		✓

CLINICAL TRIALS A PRACTICAL APPROACH

Book : ***Clinical Trials A Practical Approach***

Authors : *Stuart J. Pocock*

Publisher : *Wiley; 1st edition (January 20, 1984)*

Hardcover : *278 pages*

ISBN-10 : *0471901555*

ISBN-13 : *978-0471901556*

It is well recognized that randomized clinical trials play an important role in the evaluation of new treatments. However, the reliable achievement of genuine patient benefit depends on clinical trials being well organized and conducted according to proper ethical and scientific standards. This comprehensive text on the principles and practice of clinical trials gives a detailed account of how to conduct trials and provides a general perspective on their historical development, current status and future strategy. Each aspect of clinical trial design, analysis and interpretation is described in a non-technical manner and illustrated by actual trials. In particular, relevant statistical methods are clearly explained for clinicians and others without statistical training. This book will be essential reading for clinicians, statisticians, medical students, the pharmaceutical industry, and anyone wishing to acquire a true understanding of clinical trials

DIGEST MAIL BOX

Letter 1

Well-earned accolade

I have no hesitation on showering the accolade, 'An authority on local medicinal resources' on the 'Link Natural Digest', which I have been receiving and reading over the years. One of the latest issues of this rare Sri Lankan scientific journal, 'Quality parameters for Cassia auriculata L. Flowers', is just one case in point.

On account of its eye-opening studies on local medicinal resources and their applications, along with explorations of indigenous knowledge, which stands the test of rigorous scientific scrutiny, accompanied by aesthetically pleasing graphics and page layouts, the 'Link Natural Digest' establishes itself as a 'must read' for the scientist as well as the knowledge-hungry lay reader. Besides, the editorial staff needs to be congratulated on keeping this treasury of scientific knowledge simple and easy to comprehend.

Lynn Ockers

Associate and Business Editor , Island Newspapers

Letter 2

My dear Prof. Wijesekera:

I hope you and other colleagues at the "Link National" are doing well despite these testing times. I have with me now volume 16, issue 1, 2020 of "Link Natural Digest". I thoroughly enjoyed very high-quality content of the magazine, especially your article on Saffron.

With this letter, I just wanted to convey our gratitude to you for holding the fort, and for all goodness your towering personality is spreading to all around the world.

Prof. Dr. Muhammad Iqbal Choudhary,
H.I., S.I., T.I.
Director ICCBS/ Distinguished National Professor
Coordinator General COMSTECH
International Centre for Chemical and
iological Sciences
University of Karachi, Karachi-75270
Pakistan.

Letter 3

Link Digest is great reading and deserves the widest possible readership I do appreciate your very quick action. Glad that you enjoyed my little effort . Let me send you a few more!

Dr. Upatissa Pethiyagoda

Letter 4

Dear Dilmani,

I enjoyed reading your nice article on the castor plant in the latest digest.

Best wishes,
Prof. Ajit Abeysekera

Letter 5

Dear Ms., Dilmani,

I wish to thank the editor and the publishers of Link Natural Digest for sending me a copy of the latest Digest (Volume 16, Issue 2, 2020)

As a scientist, I have spent many hours reading the interesting articles revealing the efficacy of indigenous medicine in treating the sick

I would also like to have a copy for our library and therefore request you to send us a copy of each issue that is published.

Thank you.
Kingsley Jayasinghe
Director/ Principal
Wycherley International School (Pvt) Ltd

Letter 6

I write to acknowledge with our sincere thanks the receipt of the under mentioned publication which you have so kindly sent us to be added to our Library's collections. While thanking you for the kind gesture, we solicit your continued cooperation in future.

(Mrs.) U.G.C. Gamage
Senior Asst. Librarian,
Periodicals/ Gift & Exchange

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.

The DIGEST welcomes contributions in English in the category of reviews, brief communications, ethno reports in brief, phytomedical and phytochemical communications, book reviews, and reports on safety and efficacy of phytomedicines.

Authors may submit manuscripts byemail to :

Editor
Link Natural Digest
library@linknaturalproducts.com

Please forward to the editor one original hard copy and a soft copy in the form of a PC compatible diskette (Microsoft Word).

All manuscripts must include the following :

Title (in brief), author(s), address(es) of affiliated institutions. The authors' names must include initials and/or forenames as required in publication. All papers and submissions are subject to peer review, but the editors reserve the right to regulate the content. No proofs can be sent prior to publication. The decision of the Editor-in-Chief will be final in all matters.

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

NOTE