Link Natural

DIGEST

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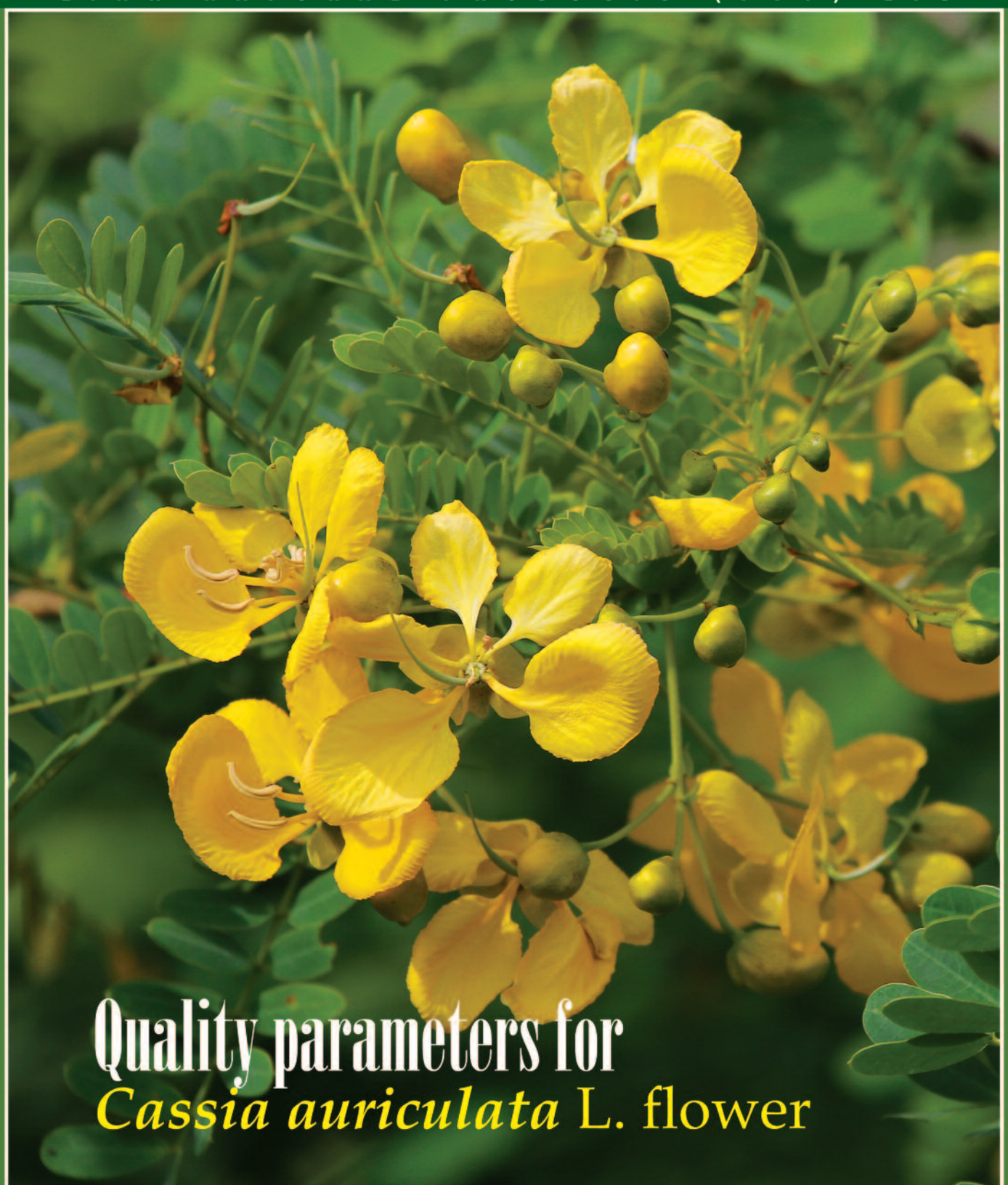

Quality parameters for *Cassia auriculata* L. flower

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IN THE PAGES THAT FOLLOW.....

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EDITORIAL

An oft pronounced adage is that "every cloud has a silver lining", and amidst this devastating and destructive pandemic, there is an element of truth in this age old expression. No doubt this disaster has wrought much physical and mental pain, and reduced many people to penury and despair, but it has also motivated many others to venture into money making enterprises with whatever talents skills they possess and which have been hitherto unexplored. And that is the silver lining shining through the dark clouds of death and disease. It is also said that "necessity is the mother of innovation" and this is indeed given credence as well by what is happening today. Both print and social media are inundated with enticing offers of home based food, drink, utility items, masks and also services. Wisely, these have commenced in a modest way, but have the potential to grow bigger and more lucrative.

While there is a frantic effort globally to find a cure and vaccine for the disease, various claims have been made as to the efficacy of different preparations, as prophylactics or immune boosting remedies. In Sri Lanka, predominant of these are ayurvedic or traditional medicines. In fact, some of these are already being used amid a vociferous protest by Western practitioners as to the ethics of using both traditional and Western medicines - the main objection being that these traditional remedies have not undergone the necessary trials to validate these claims. While this is indeed a valid point, one must also bear in mind, that many of these remedies are already in use with little ill effects being evident. Since these are preparations consumed by many for decades of time, clinical trials and such, do seem redundant. Anyway, what is important is, such concoctions could do no harm, but possibly do some much needed morale boosting to the consumer. Interestingly, the latest information doing the rounds is that one such preparation developed by an ayurvedhic doctor has been found to be most promising Thus cooperation and dialogue between Western and ayurveda practitioners seem to be desirable in order to bring about some relief by offering alternative forms of relief to the suffering masses.

Dilmani Warnasuriya

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CASTOR PLANT : MEDICINE OR POISON?

By Dilmani Warnasuriya

Preamble

Do the words "Castor oil" conjure up visions of dread and repugnance? Well, maybe not to those of the present generation, but certainly it did to those of past generations, as castor oil was dispensed to children and infants as a panacea for all ills through decades, notwithstanding its extremely bitter taste. In fact, at the first sign of illness, parents used to dose their children with castor oil as a laxative, to naturally boost immune function, either topically or internally and for the early healing of wounds. Sometimes it was even used as a means of chastisement for wrongdoings of children.

Certainly, there has to be a basis for these practices, as our ancestors had a great insight or knowledge into the medicinal use of plants. It would therefore be interesting, bearing this in mind, to foray into the many uses of castor oil and the plant itself having the added impetus of traditional medicine gaining much momentum in recent years, as having significant curative powers.

Castor (*Ricinus communis* L.) is one of the most versatile oilseed plants grown commercially, having much value as an agricultural crop. It has multiple uses as a pharmaceutical, in ethnomedicine, and also in industry where it is used as a raw material for the manufacture of various products. What is significant about the plant is that every part of it such as the stem, leaf, root, bark, flowers, seed and oil have distinct chemical compositions which are used for various purposes, mainly in pharmaceuticals and in industry. Its value is further enhanced by being a hardy plant resistant to adverse conditions and relatively easy to grow.

Immature fruits of *R. communis*

History

Castor, or *R. communis*, as classified botanically, does not have a proven or authenticated origin as various views have been expressed as to the birthplace of the plant. The generally accepted view is that it originated from Southern Asia or

India, but others maintain that it was seen in Tropical Africa or Egypt in earlier times. This is due to evidence having surfaced that the plant was observed in the sarcophagus, around mummies in ancient Egypt that are around 4000 years old. It is postulated that from Egypt the plant spread to Greece from where it reached India and China. From 500 BC it was known as an aperient among the ancient Greeks and Romans, as well as Indians, in BC 2000. It is interesting to note that castor seed was used as an arrow poison as far back as 22,000 BC owing to the presence of a poisonous compound Ricin in the seeds. Ricin has been considered a possible weapon for mass destruction and assassination by some terrorist organizations and even military establishments. To add some credibility to this, it is reported that during WW2 some US companies were preparing Ricin as Agent W. There are also numerous reports of death by ricin poisoning by accidental ingestion, assassination and murder. Several interesting anecdotes are cited as to its use for such activities throughout history. In fact, modern day murder mystery writers have also used Ricin as the causative poison in their writings. In other applications, the Greeks have documented the use of castor oil as an illuminant for lamps, fuel, and ointment for the treatment of eye irritation. In fact, different countries seem to have used the plant for various purposes, as will be seen subsequently.

According to literature it is reported that in about 1500, the castor plant was cultivated in Europe and used for skin diseases. However, no confirmation of this was reached until about 1750, when its aperient properties was recognized in Europe and used copiously. Since then the utilization of the Castor plant is worldwide not only for skin ailments and as an aperient, but for a variety of health problems as well.

The derivation of the name, *Ricinus* is somewhat diverting. It was not given haphazardly, but with some reason. *Ricinus* in Latin means tick and *communis* denotes common. So, the name stemmed from the fact that the seed of the plant resembled a tick, and the plant is commonly seen throughout the world. It is also called Palmae Christi, which stands for "into palm of Christ" owing to the shape of the leaf.

Features of the Plant

Kingdom	:	Plantae
Order	:	Malpighiales
Family	:	Euphorbiaceae
Genus	:	Ricinus
Species	:	*R. communis*

Castor plants

The Castor plant is an annual or perennial shrub belonging to the Family Euphorbiaceae. Cultivation is mainly in tropical and sub-tropical areas worldwide. It has wide variation in growth habits, colour of leaves, stem and seeds and oil content, depending on its habitat. It could be said to be xerophytic in nature and a heliophile plant, with a deep tap root system. Castor is a hardy crop, resistant to drought and other biotic and abiotic stresses and thus easy to establish on the field. It grows well from the wet tropics to the subtropical dry regions with an optimum temperature of 20–25 °C. The high content of the oil in the seeds can be attributed to the warm climate conditions, but temperatures over 38 °C can lead to poor seed setting. Conversely, temperatures low enough to induce the formation of frost is known to kill the plant.

Its size also varies, being both a shrub and a tree in height. The plant is tall, glabrous and branched, its height varying from 4-6 m with green to red branches. The Castor stem is round or curved and often covered with a waxy bloom,

and this is what imparts its attractive red, green or purple colour. At the base it turns grey when old.

The leaves are large and palmate with five to eleven lobes and held by long petioles and as mentioned this is what earned its name as Palmae christie. Leaves too may take on a colour varying from light green to dark red.

Closeup of a castor leaf

Inflorescence

The inflorescence consists of unisexual flowers which are seen at the top of the axis in panicles. Male flowers lie at the base while the female flowers are seen at the apex. The petals and sepals are not conspicuous and are shed early. The fruit has three chambers and is a globose capsule with soft spines. When maturity is reached, they split up into three cavities and the seeds are expelled explosively. However not all varieties manifest this practice. The seeds are flat, ovoid, fleshy and covered with a greyish or silvery and sometimes dotted seed coat.

It is the only species in the genus, although several sub species and varieties exist. Furthermore, more varieties and cultivars have developed over time by horticulturists. Breeding studies are also underway to develop varieties with reduced poisons. Two varieties are known:

A perennial bushy plant with large fruits and large red seeds

A much smaller annual shrub with small grey or white seeds having brown spots.

It is interesting to note that oil from the perennial plant is used for illumination and lubrication while the oil from the annual plant is preferred for medicinal use, demonstrating the difference in chemical makeup of the two types.

Castor in Pharmacology

Castor bean is known to exhibit anti-microbial, anti-inflammatory and moisturizing properties and this accounts for its widespread use in both in medicine and industry. Castor beans, the source of castor oil, contain some allergenic (2S albumin) proteins as well as ricin; however, processed or refined castor oil is free from any of these substances and can be safely used in pharmaceutical applications.

Mature castor fruits

Castor bean

Thus, Castor has worldwide use as a pharmaceutical crop, and a myriad attribute have been merited to it, although the oil has been more exploited for several other uses in industry. Many of these medicinal practices have been passed down by past generations (and found to be effective) and although a vast number of studies have been carried out , its pharmaceutical efficacy have not been authenticated through proper clinical studies other than on rats and other animals. However, there are those who firmly believe in the efficacy of the different parts of the castor plant for pharmaceutical applications.

Basically, all the parts of castor have anti-inflammatory, anti-microbial and antioxidant properties which account for many of its uses.

It is interesting to review the alleged effectiveness of the different parts of the plant from times of yore.

Leaves

Leaves are abundantly used from ancient times in the form of a decoction or poultice as an application to the breasts of women to increase secretion of milk. It is also used in dermatology, for the treatment of sores, boils and swellings. In the powdered form it is said to be effective as an insecticide. Leaves coated with oil and warmed are applied to the abdomen of children to relieve flatulence. It is pertinent to note that in recent times, pharmacological studies of the leaf extract account for over 50% of the papers, followed by extracts of seeds.

Roots

In the Indian system of medicine, roots, in the form a decoction are used to treat lumbago, rheumatism urinary bladder disorders and allied complaints. Ethanolic extracts of the roots are used as a treatment for diabetes and found to be useful for the relief of asthmatic effects, and for allergies. A decoction of roots and leaves are effective for anal and uteral prolapse, arthritis, cough and facial palsy.

Seed

The most well-known and undisputed use of castor oil extracted from the seeds, is as a laxative and purgative, well adapted for young children. It is also said to be most effective to alleviate obstinate constipation. Seed oil has been used for centuries for various skin problems in dermatology including eczema. In China, renowned for its traditional medicines, castor seed and oil have been used as dressings and stimulation of childbirth and expulsion of the placenta.

Studies during the last few decades on the chemistry and pharmaceutical action of the extracts of the seeds, have shed light on the mechanism of action of the toxins and this led to a major effort to target these toxins to malignant cells, in the treatment of cancer. This is a significant development.

The different medicinal uses of the plant worldwide are grouped according to their pharmacological action, whether authenticated or presumed. Different countries have different applications, but its use in inflammation treatment overlies them all.

Various claims have been made by research in many countries on the pharmacological uses of the different parts of the castor plant. These claims have to be viewed with caution, as very few or no clinical studies have been carried out except on animals. However, it is undisputable that the plant contains several active components known to be effective in the treatment of several diseases. The following chart will be illustrative of this.

Table 1. Pharmacological activities of castor oil plant

Pharmacological Activities	Plant Part/ Crude Extract	Active Principle
Antifertility activity	Methanol extract seed	Steroids and alkaloids
Anti-implantation activity	Methanol extract of *R. communis* var. minor	Ether soluble portion of the methanol extract
Antinociceptive activity	Methanol leaves extract	Saponins, steroids and alkaloids
Anticancer activity	Plant extract	Ricin A (Lectin)
Antioxidant activity	Seed extracts	Methyl cinoleate, ricinoleic acid, and phenolic compounds
Immunomodulatory activity	Leaves	Tannins
Hepatoprotective activity	Ethanol leaves extract	Flavonoids and tannins
Antidiabetic activity	Ethanol roots extract	-
Antiulcer activity	Seeds oil	-
Antimicrobial activity	Petroleum ether and acetone extracts of root and hexane and methanol extracts	-
Insecticidal activity	Castor oil	-
Antihistaminic activity	Ethanolic root extract	-
Anti-asthmatic activity	Ethanol root extract	Flavonoids or Saponins
Cytotoxic activity	Leaves extract	Monoterpenoids
Anti-inflammatory activity	Methanol leaves and root extract	Flavonoids
Wound healing activity	Castor oil	Tannins, Flavonoids, Triterpenoids and Sesquiterpenes

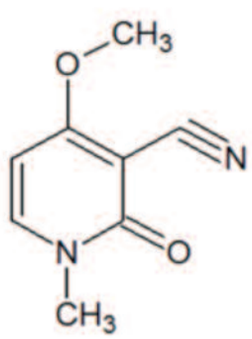
G.Esteru Raniand & G.Gaddeyya. in European Journal of Biomedical and pharmaceutical sciences 2017, Vol.4 Issue 12, pp. 300-306

Chemistry of the Plant

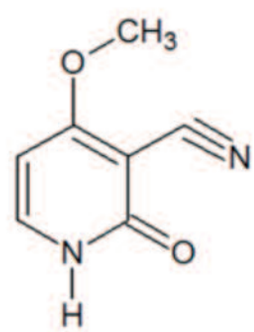
Why is Castor considered an important oilseed crop? Certainly, by the comparatively small extent of worldwide cultivation, being only 0.15% of the vegetable oil produced in the world, this could be disputable. However, Castor has the important property of yielding the only vegetable oil which contains a large quantity of the hydroxylated fatty acid, ricinoleic acid which is a valuable input in the manufacture of a variety of industrial products. The seeds contain from 40 - 60% oil, of which about 90% consists of this acid. It is thus considered to be the only commercial source of this compound, ricinoleic acid. Due to its presence, castor oil is a valuable chemical in feedstocks, commanding a higher price than other seed oils.

Several chemical studies have been carried out on the constituents of the castor oil, seed, leaf, stem and even roots. The main emphasis of many of the on-going studies is to correlate the attributed pharmaceutical properties with the chemical entities identified. The main constituents of *R. communis* identified come under the categories of steroids, saponins, alkaloids, flavonoids and glycosides.

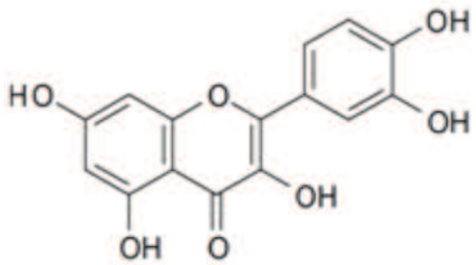
The dried leaves of the plant showed the presence of two alkaloids ricinine, and N-demethylricinine and six flavones. Mono terpenoids 1, 8 –cineole, camphor and alpha pinene, a sesquiterpenoid beta caryophyllene, and phenolic compounds gallic acid, quercetin, Gentisic acid, rutin, epicatechin and ellagic acid. The leaves are also rich in potassium nitrate.



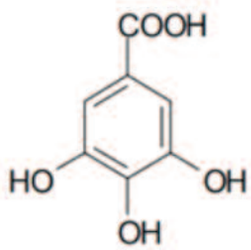
Ricinine



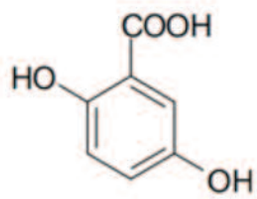
N-demethylricinine



Quercetin



Gallic acid



Gentisic acid

The stem also contains Ricinine and several sterols, the most significant being stigmasterol.

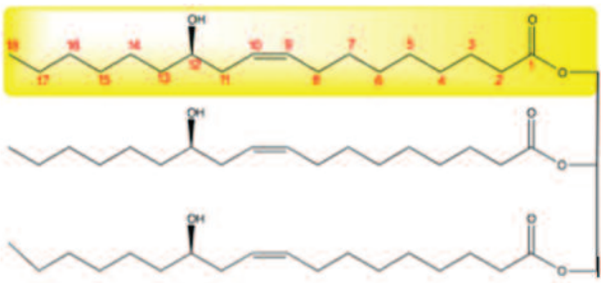
Analysis of the roots have shown the presence of one ricinus aglutinin and indole 3 acetic acid.

The seeds also contain three toxic proteins, Ricin A, B and C and the pericarp of the fruits contain the alkaloid ricinine.

Castor seed oil

To reiterate, the Castor Seed oil is the most exploited part of the plant and has a variety of industrial uses. The oil is obtained by pressing the seeds in a systematic manner and conditions which could vary depending on the end use. The oil is colorless or pale-yellow liquid with a distinct taste. The chemical constituents are mainly triglycerides in which approximately 90 percent of fatty acid chains are ricinoleates. Oleates and linoleates are the other significant components. A breakdown of the constituents is given in Table 2.

The unique character of the oil stems from the fact that the chemical reactivity of the alcohol group in ricinoleic acid allows chemical derivatization, and this is not possible with most other seed oils.



Chemical structure of Ricinoleic acid, the primary component of castor oil

Table 2.
The Chemical constituents of castor seed oil

Average composition of castor seed oil / fatty acid chains	
Acid name	**Average Percentage Range**
Ricinoleic acid	85–95
Oleic acid	2–6
Linoleic acid	1–5
α-Linolenic acid	0.5–1
Stearic acid	0.5–1
Palmitic acid	0.5–1
Dihydroxystearic acid	0.3–0.5
Others	0.2–0.5

Vinay R. Patel, etal in Lipid Insights 2016; 9. Pp 1-12

The oil also contains globulins, cholesterol, lipase, Vitamin E or tocopherol, and sterols. β sitostrerol was identified as being the most important sterol present.

The unique structure of castor oil offers interesting properties, making it appropriate for various industrial applications.

Other Uses

Other than its pharmacological, uses, castor oil is an important adjunct in industry.

Commercially produced Castor oil and its derivatives are used in the manufacturing of soaps, lubricants, hydraulic and brake fluids, paints, dyes, coatings, inks, cold resistant plastics, waxes and polishes, nylon, pharmaceuticals and perfumes. However, the processing of the seeds in oil extraction have to be carefully carried out depending on its intended use.

Motor car enthusiastics will be interested to know that Castrol, is made from Castor oil. Castrol is a British brand of industrial and automotive lubricants offering a wide range of oils, greases and similar products for most lubrication applications. The oil is resistant to breakdown at high temperatures and release low amounts of tars.

Castor cake

After extraction of the oil, the Castor cake or meal remaining, is used as a manure in parts of India. It is rich in Nitrogen and other minerals and found to be suitable of crops such as paddy, sugarcane, tobacco among others. However, as mentioned, the seed meal contains ricin and allergen and its value as an animal feed is only if it is certified that the components have been inactivated usually by heat and hydrolytic treatment.

Castor cake for cattle feed

The Bane of Castor

R. communis has gained notoriety as being the most poisonous plant on earth, in spite of its

many beneficial and health-giving uses. The nefarious uses as a toxin have been described earlier. The toxic compound in the plant is Ricin, which is a lectin or carbohydrate binding protein which is present in the castor bean. However, ingestion of the seeds of the bean is rare, and although some animals ingest the whole seed, it passes out through the alimentary tract, causing no harm. Damage to the seed coat usually by chewing is required to allow the ricin to be available for absorption. If properly manufactured, castor seed oil should not contain Ricin. Commercially available cold pressed castor oil is not toxic to humans in normal doses either internally or externally. Our forefathers would not have been using it as a medicine, if so. Ricin poisoning begins within a few hours after ingestion, these symptoms being vomiting, stomach irritation, blood diarrhea increased heart rate, low blood pressure, collapse, and death within a few days. Growers of castor plant as an ornamental or indoor plant could remove flower clusters as they appear, to assuage doubts about accidental poisoning.

Elimination of the toxin in the oil is a much-desired outcome and breeding efforts are underway for producing castor plants with reduced toxin content.

The seed meal residue remaining after oil extraction shows the presence of noxious proteins. Ricin is one of these proteins along with other allergens. However, the toxin which remains in the meal after the oil has been extracted, is easily removed through a simple salting out procedure.

Processing of Castor oil

Castor oil

Due to its wide use and rich value to industry, the method of processing of castor oil assumes great importance. Each industrial product may require different attributes of the oil. Thus, bulk of the commercial oil is processed in different ways.

Castor seed contains about 30–50% oil (w/w). This oil can be extracted from the beans by either mechanical pressing, solvent extraction, or a combination of pressing and extraction. Initially, after harvesting, the seeds are allowed to dry naturally so that the seed hull will split open, releasing the seed inside. The hull is then removed from the seeds either mechanically using a bean dehuller or manually. The first option is preferred. The seeds are then cleaned of any foreign matter such as plant parts, dirt and sand using revolving screens or reels. For the removal of iron, magnets are used appropriately. The extraction process works better when the interior of the seeds is hardened and thus the seeds are warmed in a steam jacketed press to remove moisture. The cooked seeds are then dried before the extraction process begins. Crushing of the seeds to remove the oil then follows and for this purpose, a continuous screw or hydraulic press oil expeller.

Refining of the oil follows and after filtration, the crude oil is sent to a refinery for further processing. During the refining process, impurities such as colloidal matter, phospholipids, excess free fatty acids (FFAs), and colouring agents are removed from the oil. This increases the shelf life of the oil. The refining process steps include degumming, neutralization, bleaching, and deodorization. The refined castor oil ideally has long shelf life of around one year, as long as it is not subject to excessive heat.

Markets for Castor oil

The oil is a much-valued commercial oil, costing around 2-3 times that of soybean oil, sunflower and canola oils. A causative factor for this could the fact that it is available from very few countries. India is at present both the biggest grower and also the biggest exporter of the oil. It accounts for around 83% of total global exports in

the world. Its main trading partners in this specific sector are China, Europe, Thailand and Japan.

Even though castor oil accounts for only 0.15% of the world production of vegetable oils, worldwide consumption of this commodity has increased more than 50% during the past 35 years. So much so that in general, the current rate of castor oil production is not considered sufficient to meet the anticipated increase in demand. In recent years, every effort is being made in most countries to reduce the dependency on petrochemicals and embark on the use of renewable resources and biomaterials, and this could be a primary factor driving the growth of the global castor oil market. The rising cost of other renewable resources and implementation of strict regulations regarding the use of eco-friendly products by government could be another. To further increase the demand manufacturers have begun launching various new products formulating castor oil.

However, variable prices of the castor plant, weather uncertainties and shortage of working capital and most recently the Covid-19 pandemic could act as a deterrent towards the market growth.

Future Developments

And what of the future? With the interest shown in the chemical constituents of the Castor plant, with regard to its pharmacological activity, no doubt, the pharmaceutical industry will derive many benefits in the formulation of medicinal drugs for the market. Chemists and other researchers are provided with endless opportunities to develop new applications for the oil. This could induce more cultivations in more countries to meet the burgeoning demand. Presently, industry is limited in its operations, due to the limited availability of the oil our forefathers should be felicitated for their wisdom in demonstrating to future generations the bounties that nature offers towards the health and safety of the people.

Acknowledgement

The input by Nadeesha Gunasekara in providing the illustrations is gratefully acknowledged.

References

1. Vinay R. Patel, Gerard G. Dumancas, Lakshmi C. Kasi Viswanath, Randall Maples, and Bryan John J. Subong. (2016) Castor Oil: Properties, Uses, and Optimization of Processing Parameters in Commercial Production. Lipid Insights (9): pp. 1-12
2. G. Esteru Rani and G. Gaddeyya (2017) A comprehensive review on botanical and pharmacological aspects of castor plant (*Ricinus communis* L.). European Journal of Biomedical and Pharmaceutical sciences (4)12: pp. 300-306.
3. Rana, M., Dhamija, H., Prashar, B., & Sharma, S. (2012). *Ricinus communis* L.-a review. International Journal of PharmTech Research 4(4): pp. 1706-1711.
4. Jena, J., & Gupta, A. K. (2012). *Ricinus communis* Linn: a phytopharmacological review. International Journal of Pharmacy and Pharmaceutical Sciences 4(4): pp. 25-29.
5. Scarpa, A., & Guerci, A. (1982). Various uses of the castor oil plant (*Ricinus communis* L.) a review. Journal of ethnopharmacology 5(2): pp. 117-137.
6. Bhakta, S., & Das, S. K. (2015). In praise of the medicinal plant *Ricinus communis* L.: A review. Global Journal of Research on Medicinal Plants & Indigenous Medicine 4(5): pp. 95.
7. Esteru Rani G. & Gaddeyya G. (2017). A comprehensive review on botanical and pharmacological Aspects of castor plant *(Ricinus communis* L.). European Journal of Biomedical and Pharmaceutical sciences 4(12): pp. 300-306.
8. Abbas, M., Ali, A., Arshad, M., Atta, A., Mehmood, Z., Tahir, I. M., & Iqbal, M. (2018). Mutagenicity, cytotoxic and antioxidant activities of *Ricinus communis* different parts. Chemistry Central Journal 12(1): pp. 3.
9. McKeon T.A., (2016). Castor (*Ricinus communis* L.). Industrial Oil Crops, pp. 75-112
10. Salihu, B. Z., Gana, A. K., & Apuyor, B. O. (2014). Castor oil plant (*Ricinus communis* L.): botany, ecology and uses. International Journal of Science and Research, 3(5): pp. 1333-1341.

11. Khan Marwat, S., Khan, E. A., Baloch, M. S., Sadiq, M., Ullah, I., Javaria, S., & Shaheen, S. (2017). *Ricinus communis*: Ethnomedicinal uses and pharmacological activities. Pakistan journal of pharmaceutical sciences, 30(5): pp. 1815-1827
12. Ribeiro, P. R., de Castro, R. D., & Fernandez, L. G. (2016). Chemical constituents of the oilseed crop *Ricinus communis* and their pharmacological activities: a review. Industrial Crops and Products (91): pp.358-376.
13. http://poisonousplantssrilanka.blogspot.com/2009/11/poisonous-plants-in srilanka.htmlhttp://poisonousplantssrilanka.blogspot.com/2009/11/poisonous-plants-in-srilanka.html
14. https://www.plantsguru.com/ricinus communis-castor-oil-plant-seeds
15. https://www.agrifarming.in/wpcontent/uploads/2016/04/Castor-Farming.-1.jpg
16. https://i.pinimg.com/originals/43/e6/7b/43e67b4bdcf46c34226de88f2f526184.jpg
17. https://shayandcompany.com/castor-oil-usp-grade.html
18. https://5.imimg.com/data5/GR/XP/MY-32231365/castor-cake-500x500.jpg
19. https://www.childrens.health.qld.gov.as-communis/#iLightbox[gallery_image_1]/0

A GRATIFYING RESPONSE TO THE DIGEST BY AN ENTERPRISING READER

"After seeing the article on jack-seeds by Dilmani Warnasuriya, Vol.16, No.1, I used the almond-biscuit recipe, attached, to make biscuits by substituting almond flour with jack-seed flour.

The seeds were air-dried using an air-fryer and powdered using the Kenwood Chef extruder., shown below.

The biscuits had a slight chocolate flavour and my grandchildren loved it. Later I did the same with del-cos ata which gave a much better flavour.

The recipe attached below is the original one from Kenwood recipe"

Dr Gamini Kulatunga

K BEATER RECIPE
ALMOND BISCUITS

SERVES	Makes 12 biscuits
PREP TIME	10 mins
COOKING TIME	12-15 mins
DIFFICULTY	●
EQUIPMENT	Baking tray, baking paper, flat pan
TOOLS	

INGREDIENTS

12 whole almonds, skinless
150g unsalted butter
200g caster sugar
½ tsp baking powder
150g flour
150g ground almonds
1 egg, beaten
1 tsp almond extract

METHOD

- Heat the oven to 180°C and line a baking tray with baking paper.
- Toast the 12 whole almonds in a dry flat pan and set aside.
- Add the sugar and butter to the bowl, attach the K beater and mix on a high speed until pale and fluffy.
- Add the baking powder, flour and ground almonds and mix well on a medium speed for one minute, then add the egg and almond extract and beat well until fully incorporated.
- Drop tablespoon sized amounts of the mixture onto the baking tray, leaving a good space between each one, top each one with the toasted almonds.
- **Cook in the oven for 12-15** minutes until golden. Remove and cool on a wire rack.

YOUNG SHOOTS OF BAMBOO (*BAMBUSA VULGARIS* SCHRAD. EX J. C. WENDL.): AN EMERGING FUNCTIONAL FOOD

*By Nayanathara Thathsarani, Chanika Jayasinghe, Uthpala Jayawardena, Nayanakanthi Nilakarawasam**

***Bambusa vulgaris* Schrad. Ex J. C. Wendl. (Bamboo)**

Bamboo is intricately coupled with humans from times immemorial and has been closely associated with Asia as a major plant resource. They are plants of global interest due to their distinctive life forms, ecological importance, immense utilities and values rendered towards humans, including its industrial usage. Hence, bamboo has been variously called "poor man's timber", "cradle to coffin plant" etc. *B. vulgaris* (Poaceae) is a rhizomatous plant which is generally known as Golden bamboo and it is native to Southern China.

As an exotic cultivated plant, *B. vulgaris* could be observed in the wet zone of Sri Lanka since the climatic conditions of the wet zone are well suited for the plant growth. Golden bamboo in Sri Lanka is mostly popular for its horticultural and ornamental value which is purely based on economic significance. Despite its economical uses, it is a premier medicinal plant (leaves and shoots) in treating different ailments in TCM (Traditional Chinese medicine), Indian Ayurveda and in Sri Lankan traditional medicine. The young shoots of bamboo are considered as one of the five best functional foods in the world. Moreover, it is considered as a lucky plant in far eastern countries. That a bamboo bush if grown in domestic garden will keep away psychic and physique maladies is a known age-old traditional belief. The novel explorations which had been unfolded so far were able to nourish the above statement with credible in vitro and in vivo laboratory studies.

Botany and distribution of *B. vulgaris*

Bamboo is the common name given to altogether 1575 species of perennial evergreen woody plants belonging to subfamily Bambusoideae of true grass family Poaceae, a monocotyledon in the division angiosperms. It is a tree like clump and grows 10 - 20 m high (Figure 1). They form green striped yellow culms which are 4 - 10 cm in diameter with rings of hairs. Nodes are not prominent. The stems are with hollow internodes. Leaves are linear and apex is slender with parallel veins. Leaf sheaths are hairy to a

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little extent. Young shoots are covered with overlapping hairy sheathes. A new emerging young aerial stem is termed as a bamboo shoot. The young shoots are tightly clasped with overlapping sheathes that have to be removed to obtain the delicate edible part. The freshly harvested shoot is cream yellow colour, with a strong smell and a characteristic taste. The overlapping sheaths must be carefully removed since the dense cover of tiny hairs may cause sudden irritation upon the skin. Flowers bloom very rarely. Fruits are unknown since it fails to produce seeds.

a

b

c

Figure 1. Clump, leaves, culm, flower and young shoot of *B. vulgaris* (a – clump, b - leaf and a young shoot, c –flower)

The distribution of major species of bamboo includes the regions of Asia Pacific, South America and much less in Africa. India, the neighbouring country of Sri Lanka also provides evidences for the presence of indigenous and exotic species of bamboo. Bamboo prefers a warm climate, plenty of moisture and productive soil except alkaline soil, desert and marshes, to propagate favourably. Thus, *B. vulgaris* also prefers more or less the similar ecological requirements. Sri Lanka being a country near to the equator, experiences a tropical climate, with a favourable temperature and a rainfall pattern year around. These conditions may have contributed greatly to the distribution of this giant clump simply in Sri Lanka especially near paddy field bunds and riverbanks.

B. vulgaris as a traditional remediation

It is interesting to know the fact that bamboo is not only closely related to indigenous culture and traditional claims of Asia but also in Africa and Latin America as well. The documented literature has mentioned that bamboo leaves, branches, shoots, seeds, roots and juice have been safely used to treat various diseases and symptoms in various traditional systems such as a Chinese traditional medicine, Indian Ayurveda, Unani etc.

Bamboo shoots including shoots of *B. vulgaris* have been considered as traditional Chinese medicinal material for more than 2000 years. Bamboo shoots of edible bamboo species have a long history of being used as source of both food and medicine in China and Southeast Asia. Shoots have been used to promote gut health such as intestinal peristalsis and digestions.

Ethnobotanically, *B. vulgaris* has been used to treat several diseases, including communicable diseases such as sexually transmitted infections. Different parts of *B. vulgaris* have also notably appeared in treating microbial and fungal diseases. Non-contagious diseases such as diarrhoea, diabetes, cough, asthma, cancers and hypersensitivity diseases have also been treated with bamboo. It has been effectively used to mitigate inflammatory disease symptoms such as fever.

One of the Sri Lanka's traditional claims is to use fresh juice of *B. vulgaris* young shoots as a powerful remedy in treating Dengue. Furthermore, *B. vulgaris* is effectively used in the country to treat asthma, cough, paralysis, general debility and fever. That might be the reason for calling the local bamboo varieties as "Una" (fever) in Sinhalese language. People are unaware and amazed when they heard that bamboo is a herbal remedy for many ailments. Thus, these traditional claims provide evidence that *B. vulgaris* has also been given an important place among the other herbs used in traditional medicine practices of Sri Lanka.

B. vulgaris shoots as a functional food

Unlike traditional decoctions, nutraceuticals are recommended for frequent consumption due to their safe therapeutic effects and favourable tastes along with the nutritional supply. Functional food play an important role as a novel kind of health tool that renders specific effects related to particular food components such as phytochemicals. From the toxicological perspective, nutraceuticals are recognized generally as safe at dietary doses. But, these entities are habitually consumed at higher doses in the form of nutritional supplements. Unintentionally the consumer gains both the nutrition and the health benefit collectively.

All species of bamboo spread in worldwide are not attributed as edible. The utilization pattern of bamboo shoots in many countries either as fermented, boiled, canned, raw or dried indicate its possible way of consumption. Juvenile shoots of genera *Bambusa* including *B. vulgaris* have been considered as edible.

Nutritional value

Nutritional status of bamboo shoots is amazing. Shoots are rich in nutrient components, mainly proteins, amino acids, carbohydrates, fibres, inorganic salts and minerals with a very low amount of fats and cholesterol. Proteins specially are at their peak amounts in newly emerged young shoots, containing an average of 2.65 g per 100 g of fresh bamboo shoots. The nutritional

profile includes 17 amino acids, 8 of which are essential for the human body. The total sugar content, 2.5% on average, is relatively low when compared with other vegetables. Fat content is comparatively low (0.26% to 0.94%) and the shoots are rich with essential fatty acids. The water content is around 90% or more making them an ideal functional food.

Bamboo possesses a good profile of minerals, potassium, calcium, manganese, zinc, chromium, copper, iron, lower amounts of phosphorus and selenium. Fresh shoots are a better source of thiamine, niacin, vitamin A, vitamin B6, and vitamin E. Nutritional studies has determined that bamboo shoots are a good energy generating food source and has been recommended as a novel health food. However, due to the presence of hydrocyanin (HCN) it develops bitterness in bamboo shoots. Shoots are believed to be free from residual toxicity since no fertilizer is used for bamboo propagation. Only shoots contain a potentially toxic glycoside of a-hydroxy nitrile called taxiphyllin. Taxiphyllin tends to break down to form cyanohydrins and sugar with the activation of hydrolytic enzymes, and then abruptly decomposes to HCN which is responsible for the featured bitterness. Superheated steam drying under low temperature removes HCN from bamboo shoots. This turn, degrades taxiphyllin at around 116 °C. This could be the reason for high consumer demand for processed bamboo shoots as a harmless dietary intake.

Medical value

The research curriculum of *B. vulgaris* proves its potency and fundamental role in mitigating a spectrum of diseases and imbalances of the physiology when healthy living is considered. Modern research has revealed antioxidant, anti-inflammatory, anti-microbial, anti-diabetic and wound healing activities (Table 1) from different parts of *B. vulgaris* among the little scientific validations of the bioactivities of this plant apart from the other major bamboo species.

Table 1:
Bioactivities of various parts of *B. vulgaris*

Property	Part of the plant used	Reference
Antioxidant	Leaves	Goyal et al (2010)
Anti-microbial	Leaves	Owolabi and Lajide et al (2015)
Anti-inflammatory	Leaves	Lu et al (2005), Lodhi let a (2016)
Abortifacient	Leaves	Musa and Bimbo (2009)
Anti-microbial	Shoots	Naidu (2011)
Anti-diabetic	Leaves	Senthilkumar et al (2011)
Wound healing	Leaves	Lodhi et al (2016)
Anti-proliferative	Shoots	Ambika & Rajagopal, (2017)

However, research studies on immuno-modulatory properties of *B. vulgaris* are largely lacking in the scientific records except for very few attempts. Recently our group, established the immunomodulatory and immunosuppressive properties of fresh juice of *B. vulgaris* young shoots using in vivo rat model. Hence, it would be a timely requirement to test the immunomodulatory properties of *B. vulgaris* with clinical trials even in treating respiratory viral diseases and non-communicable diseases, with a boiled portion of its young shoot to investigate for the presence of previously encountered immunomodulatory properties with the fresh juice. Thus, it will significantly provide the way forward in-order to produce a better herbal drug

which can be utilized also as a nutraceutical in near future.

Conclusion

Although the primary role of diet is to provide nutrients to meet metabolic requirements, recent scientific investigations have revealed that diet may provide medicinal requirements as well. Recently, various terms such as "functional food" and "nutraceuticals" have been proposed to designate foods for health promotion and disease prevention. The concept of consuming functional food has upsurged to fulfil the pertinent requirement to assist the survival of humans by strengthening the immunity through dietary intake as a promising safe route. Shoots of *B. vulgaris,* with their high nutritive value and range of bioactive compounds, hold great promise for utilizations as a health food. Though, it is consumed as a routing meal in Asian communities, in the western countries, bamboo shoots are available in canned form, imported from Asia providing a good income to the Asian region. Bamboo plant species are usually identified as a potential source of mosquito breeding sites. When wide spreading of this plant is controlled by utilizing the benefits of young shoots, it eventually paves the way to indirect controlling of mosquito breeding sites. The scientific evidence available thus far, have laid the baseline to open a new arena in the research field to promote *B. vulgaris* as a potential functional food and thus its nutritional, medicinal, economic and ecological benefits would be enormous.

"Let food be thy medicine"- Hippocrates

References

1. Ambika, K. and Rajagopal, B., (2017). In Vitro Antimicrobial and Antiproliferative Activity of *Bambusa vulgaris*. International Journal of Pharmacy and Pharmaceutical Research, 9(1), pp.10-22.
2. Ashton, M.S., Gunatilleke, S., De Zoysa, N., Dassanayake, M.D., Gunatilleke, N. and Wijesundera, S., (1997). A field guide to the common trees and shrubs of Sri Lanka (pp. 430). Colombo, Sri Lanka: WHT Publications.
3. Bao, J., (2006). The nutrition and bioactive function of bamboo shoots. Food Nut in China, 4, pp.2-3.
4. Bystriakova, N., Kapos, V., Lysenko, I. and Stapleton, C.M.A., (2003). Distribution and conservation status of forest bamboo biodiversity in the Asia-Pacific Region. Biodiversity & Conservation, 12(9), pp.1833-1841.
5. Carey, W.M., Dasi, J.M.B., Rao, N.V. and Gottumukkala, K.M., (2009). Anti-inflammatory activity of methanolic extract of *Bambusa vulgaris* leaves. International Journal of Green Pharmacy, 3(3).
6. Chongtham, N., Bisht, M.S. and Haorongbam, S., (2011). Nutritional properties of bamboo shoots: potential and prospects for utilization as a health food. Comprehensive Reviews in Food Science and Food Safety, 10(3), pp.153-168.
7. Chopra, R.N., Nayar, S.L. and Chopra, I.C., (1956). Glossary of Indian medicinal plants. New Delhi: Publication and Information Directorate. Council of Scientific and Industrial Research, 229.
8. Choudhury, D., Sahu, J.K. and Sharma, G.D., (2010). Biochemistry of bitterness in bamboo shoots. Assam University Journal of Science and Technology, 6(2), pp.105-111.
9. Goyal, A. K., Middha, S. K., & Sen, A. (2010). Evaluation of the DPPH radical scavenging activity, total phenols and antioxidant activities in Indian wild *Bambusa vulgaris* " Vittata" methanolic leaf extract. Journal of Natural Pharmaceuticals, 1(1).
10. Hardy, G., (2000). Nutraceuticals and functional foods: Introduction and meaning. Nutrition (Burbank, Los Angeles County, Calif.), 16(7-8), pp.688.
11. Holstege, C.P., (2010). Criminal poisoning: clinical and forensic perspectives. Jones & Bartlett Publishers.
12. Lodhi, S., Jain, A.P., Rai, G. and Yadav, A.K. (2016) 'Preliminary investigation for wound healing and anti-inflammatory effects of *Bambusa vulgaris* leaves in rats', Journal of Ayurveda and integrative medicine, vol. 7, no. 1, pp. 14-22.

13. Lu, B., Wu, X., Tie, X., Zhang, Y. and Zhang, Y., (2005). Toxicology and safety of antioxidant of bamboo leaves. Part 1: Acute and subchronic toxicity studies on antioxidant of bamboo leaves. Food and Chemical Toxicology, 43(5), pp.783-792.
14. Naidu, M.A., (2012). Antimicrobial Activity of Methanolic Extracts of Bamboo Shoots (*Bambusa vulgaris*). International Journal of Pharmaceutical & Biological Archives, 3(6), pp.1547-1549.
15. Nasri, H., Baradaran, A., Shirzad, H. and Rafieian-Kopaei, M., (2014). New concepts in nutraceuticals as alternative for pharmaceuticals. International Journal of Preventive Medicine, 5(12), pp.1487.
16. Nazreen, S., Alam, M.S., Hamid, H., Kaur, G., Alam, M.M., Haider, S., Shafi, S. and Ali, M., (2011). Phytochemical investigation of *Bambusa* arundinacea Retz. Internationl Journal of Natural Product Science, 3, pp.1-7.
17. Nirmala, C., David, E. and Sharma, M.L., (2007). Changes in nutrient components during ageing of emerging juvenile bamboo shoots. International Journal of Food Sciences and Nutrition, 58(8), pp.612-618.
18. Ogunwusi, A.A., (2011). Potentials of bamboo in Nigeria's Industrial Sector. Journal of Research in Industrial Development, 9(2), pp.136-146.
19. Owolabi, M.S. and Lajide, L., (2015). Preliminary phytochemical screening and antimicrobial activity of crude extracts of *Bambusa vulgaris* Schrad. Ex JC Wendl.(Poaceae) from southwestern Nigeria. American Journal of Essential Oils and Natural Products, 3(1), pp.42-45.
20. Ozen, A.E., Pons, A. and Tur, J.A., (2012). Worldwide consumption of functional foods: a systematic review. Nutrition reviews, 70(8), pp.472-481.
21. Sastry, C.B., (2008), April. A 2020 vision for bamboos in India: Opportunities and challenges. In Proceedings of International Conference "Improvement of Bamboo Productivity and Marketing for Sustainable Livelihood. New Delhi, pp. 6-15.
22. Senthilkumar, M.K., Sivakumar, P., Changanakkattil, F., Rajesh, V. and Perumal, P., (2011). Evaluation of anti-diabetic activity of *Bambusa vulgaris* leaves in streptozotocin induced diabetic rats. International Journal of Pharmaceutical Sciences and Drug Research, 3(3), pp.208-210.
23. Thathsarani N., Jayasinghe C.D., Jayawardena U., and Nilakarawasam N., (2018). Immunosuppressive activity of fresh juice of *Bambusa vulgaris* young shoots in rats. Asian symposium on medicinal plants, spices and other natural products XVI, pp.174.
24. Thathsarani N., Jayasinghe C.D., Jayawardena U., and Nilakarawasam N., (2019). Immunomodulatory effect of fresh juice of *Bambusa vulgaris* young shoots. Open University research sessions, pp.15.
25. Thathsarani N., Nayanajeehwi G., Jayasinghe C.D., Jayawardena U., and Nilakarawasam N., (2020). Cancer chemoprevention through functional food of plant origin. Asian journal pharmacy and pharmacology, 6(2), pp. 132-143.
26. Wang, D., and S.J. Shen. (1987). Bamboos of China. Timber Press, Portland, Oregon. pp. 428.
27. Watson, L., Dallwitz, M.J. and Johnston, C.R., (1986). Grass genera of the world: 728 detailed descriptions from an automated database. Australian Journal of Botany, 34(2), pp. 223-230.

Time

There are some things that cannot be learned quickly, and time, which is all we have, must be paid heavily for their acquiring. They are the very simplest things, and because it takes a man's life to know them, the little new that each man gets from life, is very costly, and the only heritage he has to leave.

Ernest Hemmingway

ECTOINE FROM MICROORGANISMS: A NATURAL INGREDIENT FOR PHARMACEUTICAL AND COSMETIC INDUSTRY

*By I.V.N. Rathnayake**

Microbial life in hypersaline environments

Microorganisms are the predominant inhabitants of hypersaline environments (with salt concentrations up to saturation of approximately 300 g/L of Sodium Chloride). Most of the salt tolerant (halophilic) and salt loving (halotolerant) microorganisms produce and/or accumulate several organic compounds in their cells to provide osmotic balance with their hypersaline environment. These organisms thus can remove salt from their cytoplasm, which eliminate their requirement to adapt their proteins to the presence of high salt concentrations. A range of such organic compounds known as compatible solutes or extremolytes have been identified in microorganisms (e.g. sugars, polyols, amino acid derivatives). Compatible solutes are useful for microorganisms as osmoregulatory solutes. They also act as protectants of microbial proteins by reducing harmful effects of freezing, drying and high temperatures.

Ectoine - a multi-purpose osmotic solute

Ectoine (1,4,5,6-tetrahydro-2- methyl-4-pyrimi--dinecarboxylic acid), is a cyclic derivative of aspartate, an amino acid, is one of the most common compatible solutes found in bacteria. This compound was first discovered in the haloalkaliphilic photosynthetic sulfur bacterium *Ectothiorhodospira halochloris*. As of now, a great diversity of halophilic and halotolerant bacteria was found to produce ectoine.

Ectoine is gaining popularity among the pharmaceuticals and cosmetics sector since it offers many benefits to their products. Properties like for instance, anti-aging, protection of the skin from desiccation, protection of mitochondrial DNA, inhibition of ceramides mediated skin inflammation, mediation of the pro-inflammatory response of human epidermal keratinocytes, protection of the skin against harmful effects of visible light, moisturizing effect of the skin, protection of the Langerhans cells from harmful UV light, hindering the ceramides release in human epidermal keratinocytes under the stimulation of UVA, protection of the skin against dehydration due to surfactants, inhibition of melanogenisis etc., ascertain that ectoine is a promising ingredient for cosmetic and pharmaceutical industries.

This protecting effect of ectoine was observed in inflammatory conditions of other epithelia such as lung, nasal and eye epithelia. Ectoine protects the lung epithelia against nanoparticle induced airway inflammation. Ectoine containing nasal spray and eye drop products found to be effective in treating symptoms of rhinoconjunctivitis. The effectiveness is similar to the other medications containing antihistamines, steroids, and leukotriene modifiers, however with almost no side effects. A wide range of ectoine based products for allergy treatments, treatments for skin inflammatory conditions, dry eye, dry nose and rhinosinusitis have been developed and introduced into the market after successful clinical trials.

Furthermore, the potential of ectoine in preventing aggregation of amyloidogenic proteins may help in developing amyloid-inhibiting compounds for the treatment of neurodegenerative disorders such as Alzheimer's, Parkinson´s and Huntington´s and also prion-related diseases.

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Most recent studies reported that the Mucositis of cancer patients resulted due to chemotherapy and radiotherapy can be safely and effectively treated with ectoine-containing mouthwash.

Industrial production of Ectoine:

Industrial processes of ectoine production was first developed using *Halomonas elongata* and Marinococcus M52, where ectoine is extracted from halophilic bacteria. The procedure is based on the process called 'bacterial milking' where the bacteria are grown in a high salt medium so that they tend to grow into a high cell density, and in turn, they accumulate massive amounts of ectoine intracellularly. As a response to the osmotic down-shock applied, bacteria respond by secreting more ectoine to the surrounding medium. The target product ectoine is then be collected by crossflow filtration and purified subsequently. Addition of salt to the reactor medium allow re-adaptation of bacteria to high salinity, thereby allowing the bacterial milking process to be continued.

The other key technology that allow production of ectoine is the development and application of ectoine-excreting mutants ("leaky" mutant). In this method the genes responsible for the ectoine production is expressed in *Escherichia coli* or in other non-halophilic bacteria and to use the resultant recombinant bacteria as a source for the compound.

It can be concluded that the compatible solute, ectoine produced by microorganisms is a sustainable resource which opened up a promising avenue for many innovative applications in pharmaceutical and cosmetic sectors for nutrition, healthcare and wellbeing of humans and animals.

References:

1. Bergmann, S., David, F., Franco-Lara, E., Wittmann, C. and Krull, R., (2013). Ectoine production by *Alkalibacillus haloalkaliphilus* - Bioprocess development using response surface methodology and model-driven strategies. Engineering in Life Sciences, 13(4), pp.399-407.
2. Bilstein, A., Overhagen, S., Géczi, L., Baráth, Z. and Mösges, R., (2018). Effectiveness, tolerability, and safety of ectoine-containing mouthwash versus those of a calcium phosphate mouthwash for the treatment of chemotherapy-induced oral mucositis: a prospective, active-controlled, non-interventional study. Oncology and Therapy, 6(1), pp.59-72.
3. Czech, L., Hermann, L., Stöveken, N., Richter, A.A., Höppner, A., Smits, S.H., Heider, J. and Bremer, E., (2018). Role of the extremolytes ectoine and hydroxyectoine as stress protectants and nutrients: genetics, phylogenomics, biochemistry, and structural analysis. Genes, 9(4), p.177.
4. Goraj, W., Stępniewska, Z. and Szafranek-Nakonieczna, A., (2019). Biosynthesis and the possibility of using ectoine and hydroxyectoine in health care. Advancements of Microbiology, 58(3), pp.339-350.
5. Kunte, H.J., Lentzen, G. and Galinski, E., (2014). Industrial production of the cell protectant ectoine: protection mechanisms, processes, and products.
6. Oren, A., (2010). Industrial and environmental applications of halophilic microorganisms. Environmental technology, 31(8-9), pp.825-834.

Trees

Trees grow tall and wide crowned as a measure of competition with other trees, racing upward, reaching outward for sunlight and water. And a tree doesn't stop getting larger like a terrestrial mammal does, or a bird, - their size constrained by gravity – once it is sexually mature. A tree too is constrained by gravity but not in the same way as a condor or a giraffe. It does not have to locomote and it fortifies its structure by continually adding more wood

David Quammen

QUALITY PARAMETERS FOR *CASSIA AURICULATA* L. FLOWER

By Udeshika Weerarathna *

Cassia auriculata L. (Family Fabaceae) commonly known as "Tanner's cassia" is widely used in Sri Lankan folk medicine. Generally, it is known as "Ranawara" in Sinhala and "Avaram" "Avarai" in Tamil.[1]

The plant is found as shrubs or small trees (Figure 1) which grow up to about 7 m in height. Leaves are 5-12 cm long, with 6–13 pairs of leaflets, bearing erect linear glands on the rachis usually between leaflets of each pair: leaflets elliptic-oblong, rounded at apex and base, mucronate at the apex, 1–3.5 cm long, 1–2cm wide, glabrous above, puberulent or glabrous beneath; inflorescences corymbose, few-flowered but aggregated into large, terminal panicles in the axils of the upper leaves; bracts linear, attenuate, 5–7 mm long; flowers on pedicels 1.5–3 cm long; sepals yellow, rounded at the apex, pubescent at the base; petals bright yellow, 2–2.5 cm long; stamens 10, 3 with long filaments and anthers, 4 medium, and 3 reduced to staminodes; fruit linear-oblong, compressed, undulate between the seeds, pilose or minutely crisp-pubescent; 7.6–10 cm long with a stipe about 5 mm long and a persistent style 1.5 cm long, about 1–2 cm wide, 12–20-seeded; seeds brown, ovate-oblong, 7–9 mm long, 4–5 mm wide, with an areole 3–3.5 mm long, 0.5–0.75 mm wide on each face.[2]

Figure 1: Tree of C. *auriculata*

The origin of this plant is India and it grows in the dry regions of India and Sri Lanka. It is distributed along the seacoast and the dry zone in Sri Lanka [1] and is commonly found in Mihintale, Mannar, Puttalam, Peradeniya, Kadugannawa, Trincomalee, Jaffna, Nainativu, Mullativu, Kayts, Kilinochchi, Vavuniya, Bibile, Tanamalwila and Tissamaharama.[2]

The ethnomedical usage of the leaf, root bark, seed and flower of the plant have been recorded in many reviews.[3,4,5]

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Traditional Ayurveda texts describes the pharmacological effects of the flower in terms of inhibiting the excessive flow of body fluids. It is found in prescriptions for diabetes, leucorrhea, menorrhagia, polyurea and spermatorrhea. [6,7,8]

Modern pharmacological studies support the use of the flower of *C. auriculata* for diabetes. Thus, the oral administration of the aqueous extract of *C. auriculata* flower resulted in a significant reduction in blood glucose and an increase in plasma insulin of streptozocin induced diabetic rat [9]. It was also found in the same study that the extract significantly reduced the levels of serum and tissue lipids, which are actively raised in streptozotocin induced diabetes. The anti-hyperlipidemic activity of the ethanol extract of *C. auriculata* flower has also been shown in Triton WR-1339 induced hyperlipidemic rats.[10]

It is reported that the ethanol extract contains gallic acid, chlorogenic acid, rutin, quercetin, hesperidine and vitexin-2"- O- rhamnoside, based on HPLC analysis [11].

The popular herbal tea marketed by Link Natural Products (Pvt) Limited, known as "Five Herbs" (Figure 2) contain the dried flower of *C. auriculata* as one of the ingredients along with *Hemidesmus indicus* (L.) R.Br. root ('Iramusu'), *Aegle marmelos* (L.) Correa fruit ('Beligata'), *Aerva lanata* (L.) Juss. ex Schult. aerial part ('Polpala') and *Asteracantha longifolia* (L) Nees. aerial part ('Neeramulliya'). It is marketed as a health care product to rejuvenate and detoxify the body with beneficial effects on the urinary system.

Link Natural Products obtains its supply of the dried *C. auriculata* flowers (around 1000 kg per annum) from suppliers who collect the plant locally from Jaffna, Puttalam, Kurunagala, Galgamuwa, Kalpitiya and Hambantota.

The material brought to the factory is carefully screened manually for extraneous matter which is removed by physical means before subjecting it to quality testing.

Some samples are found to be contaminated with the live and dead larval stage and pupa stage of an insect, which has been tentatively identified as a moth species whose life cycle is associated with the plant (Figure 3). Parts of flowers and faecal matter of the larval stage clumped together with a cobweb like material is a common contaminant in samples of flowers (Figure 4). The adult insect is generally not found in the samples.

Figure 2. Carton and Sachets of "Link Natural Five Herbs Herbal Tea".

(a). (b). (c).

Figure 3.
Stages in the life cycle of the insect species associated with *C. auriculata*
(a). Larval stage (b). Pupa stage (c). Adult insect

Figure 4.
Lumps containing faecal matter of larval stage and flowers bound together by cobweb like material

Identification of the flower is routinely carried by morphological evaluation and comparison with the reference specimens maintained in the LINK herbarium. The flower of the closely related species *Cassia surattensis* Burm.f. which is found widely distributed in Sri Lanka has been identified as a possible adulterant of *C. auriculata* flower. The fresh flowers of these two plants are morphologically similar (Figure 5, Table 1).

(a). (b).

Figure 5.
Fresh flower of *C. auriculata* (a) and *C. surattensis* (b)

Table 1.
Morphological features of flower of *C. auriculata* and *C. surattensis*

Morphological Features of flower	***Cassia auriculata* L**	***Cassia surattensis* Burm.f.**
Color of petals	Bright yellow	Yellow
Length of pedicels	1.5-3.0 cm	2.5-4.0 cm
Length of petals	2.0-2.5 cm	2.0-3.0 cm
Number of stamens	10	10
Number of stamens with long filaments	3	3
Number of stamens with medium filaments	4	0
Number of stamens with shorter filaments	0	7
Number of staminodes	3	0

As the dried flower of *C. auriculata* and *C. surattensis* (Figure 6) are difficult to recognize separately by their morphology, a TLC system was developed to distinguish between the two species.

(a). (b).

Figure 6.
Dried flower of *C. auriculata* (a) and *C. surattensis* (b).

The ethyl acetate extract of the flowers (which contains flavonoids) was chromatographed on silica with toluene:ethyl acetate:acetic acid (4.5:4:1) as the mobile phase. Flavonoids were visualized under UV 365 nm after spraying with Natural Products Reagent followed by Polyethylene Glycol (NPR/PG). While the individual chromatograms of the two flowers were similar, *C. surattensis* could be differentiated from *C. auriculata* by the presence of a blue fluorescent band at Rf 0.4. This blue band can be recognized easily in the TLC of a 1:1 mixture of the flowers (Figure 7.)

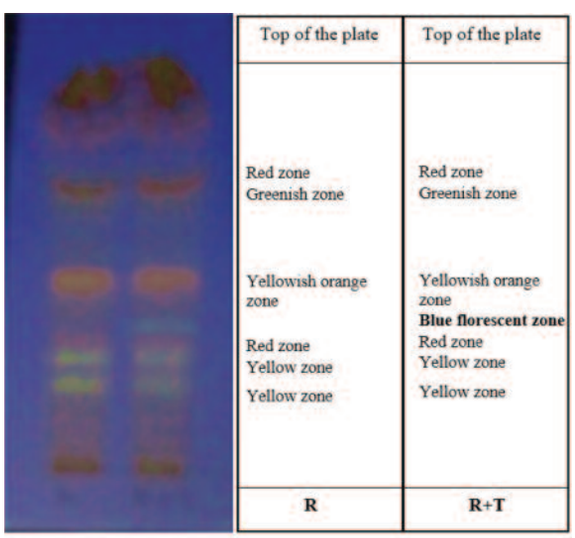


Figure 7.
TLC of the ethyl acetate extract of flowers of *C. auriculata* (track R) and a 1:1 mixture of *C. auriculata* and *C. surattensis* (track R+T).

Further experiments indicated that adulteration by *C. surattensis* can be clearly observed at 20% adulteration, while the blue band can observed very faintly even at 5% adulteration (figure 8).

Figure 8.
TLC of the ethyl acetate extract of mixtures of flowers of *C. auriculata* and *C. surattensis* in ratios (w/w) of 3:1, 4:1, 9:1 and 9.5:0.5.

Standard quality control parameters for herbal substances recommended by the WHO [12] are also applied as routine tests to ensure the quality of the material used in "Five Herbs".

The parameters and their values are given in table 2.

Table 2. Quality Parameters of *C. auriculata*

Test parameters	LNP Standard
Foreign matter % (w/w)	< 1
Loss on drying % (w/w)	< 10
Water soluble extractive value %(w/w)	> 21
Total ash % (w/w)	< 7
Acid insoluble ash % (w/w)	< 0.7
Total Aerobic Microbial Count (CFU/g)	NMT 5 x 10^5
Total Yeast and Mould Count (CFU/g)	NMT 5 x 10^4
Bile Tolerant Gram-Negative Bacteria (CFU/g)	NMT 10^4
E. coli	Absent /1 g
Salmonella sp.	Absent /25 g

Thus, the test used as an assay for active constituents is the water soluble extractive value.

We gratefully acknowledge Dr. T.M.S.G. Tennakoon, Director R & D, Link Natural Products (Pvt) Ltd, for his help in authentication of the flower of *Cassia surattensis* Burm.f., Mr. Chalitha Weerasekara, Manager, Agriculture, Link Natural Products (Pvt) Ltd for providing specimens of the different life stages of the insect and Dr. R. Gamage, Senior R & D officer (Ayurveda) for helpful discussion on the traditional uses of *Cassia auriculata* L.

References

1. Jayaweera, D.M.A. (2006). Medicinal plants used in Ceylon, Volume 3. pp. 177. National Science Foundation, Sri Lanka.
2. Dassanayake M.D. (1991). A revised handbook to Flora of Ceylon, Volume 7. pp. 79-82. Amerind Publishing Co Pvt Ltd, New Delhi.
3. Salma B., Muthukumar S.P., Avinasha S. & Manjula S.N. (2020). Review on ethnobotany, phytochemistry and pharmacological properties of *Cassia auriculata*. Pharmacy & Pharmacology International Journal 8(2): 106–111.
4. Soundharajan S.R. & Ponnusamy R.D. (2014). Chemical composition and characterization studies of *Cassia auriculata* flower extract. International journal of pharmacy and pharmaceutical sciences 6(7): 327-330.
5. Kainsa S., Kumar P. & Rani P. (2012). Pharmacological potentials of *Cassia auriculata* and *Cassia fistula* plants: A Review. Pakistan Journal of Biological Sciences 15(9): 408-417. DOI: https://dx.doi.org/10.3923/pjbs.2012.408.417
6. Kottakkal, A. V. (1995). Indian Medicinal Plants: A Compendium of 500 Species, Volume 2. pp.6-8. Orient Longman.
7. Department of Ayurveda, (1985) Ayurveda Pharmacopeia, Volume 1, pp. 297-299. Department of Ayurveda, Sri Lanka.
8. Department of Ayurveda (2003). Compendium of Medicinal plants, A Sri Lankan study, Volume 3, pp. 71-74. Department of Ayurveda, Sri Lanka.
9. Pari L. & Latha M. (2002). Effect of *Cassia auriculata* flowers on blood sugar levels, serum and tissue lipids in streptozotocin diabetic rats. Singapore Medical Journal 43(12): 617-621.
10. Vijayaraj P.S., Muthukumar K., Sabarirajan J. & Nachiappan V. (2011). Evaluation of antihyperlipidemic activity of ethanolic extract of *Cassia auriculata* flowers. Indian journal of Biochemistry and Biophysics 48: 54-58.
11. Nambirajan G., Karunanidhi K., Ganesanb A., Rajendran R., Kandasamy R., Elangovan A. & Thilagar S. (2018). Evaluation of antidiabetic activity of bud and flower of Avaram Senna (*Cassia auriculata* L.) In high fat diet and streptozotocin induced diabetic rats. Biomedicine & Pharmacotherapy (108) : 1495 - 1506. DOI : https://doi.org/10.1016/j.biopha.2018.10.007
12. World Health Organization (1998). Quality control methods for medicinal plant materials. World Health Organization, Geneva.

When Science and Politics clash

Theories are always being tested. This is how Science works. All the more reason for citizens to become as scientifically literate as possible – to figure out when the centre of gravity is in any given debate. Because at some point, a scientific civilization has to take action, uncertainties not withstanding.

Joel Achenback

Ayurveda

Ayurveda is the ultimate in holistic sciences, because it takes into account all the important natural forces which act on the human being

Rober E Swoboda

COSCINIUM FENESTRATUM (GAERTN.) COLEBR. - A RARE, ENDANGERED MEDICINAL SPECIES IN SRI LANKA

*By S. Subasinghe**

Coscinium fenestratum (Gaertn.) Colebr. is a woody climber (popularly known as "Weniwel" or "Barnwel", which grows wild in the natural habitat in the South Asian region such as Sri Lanka, South India, Thailand, Cambodia, Vietnam, Malaysia, Sumatra, Western Java and Borneo. The *C. fenestratum* is still being prematurely harvested at a higher rate from natural forest areas resulting in diminished populations due to the absence of proper cultivation strategies other than slow natural regeneration and therefore this species has been listed as endangered in the IUCN Red Data Book (Jayaweera, 2006).

Morphology of plant

C. fenestratum is a large dioecious climber up to about 10m long, with a yellowish-brown smooth bark, yellow wood and sap. Stem and root pieces are hard and woody. Branchlets are terete, tomentose and later glabrescent with disciform petiole-scars (Tushar et.al., 2008). Leaves are simple, alternately arranged, exstipulate, broadly ovate or rounded in shape, truncate or shallowly cordate at base, acuminate at apex, about 10-32 x 8-22 cm in size, glabrescent above, hairy yellowish-white tomentellous beneath. There are palmatey arranged 5-7 main nerves, with 2 distal pairs of lateral nerves where midrib and other main nerves are sunken. Petioles are 3-16 cm long inserted up to 0.8 cm above basal margin on the lamina of leaf. Stipules are absent (Tushar, et. al., 2008).

When considering the leaf variation of three different populations in Labugama, Deraniyagala and Sinharaja of Sri Lanka, different phenotypic characters in leaf shape, petiole length and lamina length are shown. The mean lamina length in particular and width showed a striking variation. The mean lamina length of plants collected from Sinharaja was larger when compared to that of plants from Deraniyagala and Labugama. The smallest leaf dimensions were observed in plants collected from Labugama (Gunatillake et. al., 2002).

Plate 1: Naturally grown liana of *C. fenestratum*

Plate 2: Female inflorescence and fruit bunch

Inflorescences are 5-11 cm long and 6-7 mm wide racemes having globose heads on 1-3 cm long

*Prof. S Subasinghe, Senior Professor, Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka

peduncles, supra-axillary or on old leafless stems. Subulate and villous bracts are closely pressed to the calyx by 4-5 mm long small peduncles (Kathriarachchi et. al., 2004). According to Tushar, et al. (2008), flowers are unisexual, small and yellowish or whitish in colour; having 9 sepals in 3 whorls which are imbricate and densely sericeous. There are no petals. Male flowers are sessile or shortly pedicellate. Broadly elliptic to obovate, 1.5- 2 mm long sepals are densely sericeous outside and glabrous inside, yellow in colour. Sepals are broadly elliptic, 1-1.5 mm long, 3-6 arranged as outer sepals while another 3-6 set as inner sepals. There are 6 stamens, 3 outer stamens are freely arranged, and inner ones are conate to the middle. Filaments are 1.0 mm long. Anthers are small, oval, adnate and outer ones are one celled while inner ones are two-celled. Pollen grains are oblate-spheroidal or rarely spheroidal and triporate. Tectum is reticulate and fine granules are present in lamina. There are 3-6 free female flowers; carpels are subglobose and styles are slender, subulate, recurved or filiform. Numer of staminodes is 6 (Tushar, et al., 2008).

Diameter of a drupe varies from 2.6 to 3.0 cm. There are 1-3 subglobose and tementellous drupes. Diameter of globose gynophore attaching the drupes is 7-8 mm. The thickness of brown, orange or yellow coloured pericarp is 1.0 mm which turns woody when dry; bony endocarp is 2.2- 2.5 cm in diameter, with persistent calyx. Seeds have stony, blackish and 1.0 mm thick seed coat which surrounds the endosperm. Embryos contain very thin, whitish to yellowish, divaricate cotyledons having irregular margins and whitish to yellowish color small superior radicle (Tushar, et al., 2008).

However, seeds with different morphological characters were identified from Sinharaja, Deraniyagala, and Labugama (Gunatillake, et al., 2002). Comparison of seed weights in three populations showed that seeds collected from Sinharaja were the heaviest followed in decreasing order by those from Deraniyagala and Labugama. Variation in seed dimensions followed the same trend as that of seed weight.

Plate 3: Drupes (fruit bunches) of *C. fenestratum*

C. fenestratum , a slow growing climber, reaches its reproductive stage within about 15 years (Tushar, et al., 2008). Even though this is a dioecious plant both male and female plants are morphologically similar. Therefore, female plants can be only identified during the fruiting season. The number of female plants was comparatively lower than the male plants. Since also all the female plants never produce fruits in the same year and mature plants only produced fruits, all the female plants may not be counted in one fruiting season (Singhakumara, et al., 2003) but Villagers believe that male and female plants could be identified by the leaf shape (oval or circular).

Medicinal uses

From root to fruit, *C. fenestatum* has high demand in Ayurvedic medicine. The major alkaloids present mainly in the stem and roots are yellow crystalline berberine-the medicinally active compound, protoberberine and jatrorrhizine (Tushar, et al., 2008). The wood is bright yellow in colour which has high demand in ayurvedic medicine. The dried stem is used as a major component for preparation of number of ayurvedic medicines in powdered, liquid and raw forms. *C. fenestratum* containing prescriptions are used for treating diseases of skin, uterus,

urinary system, eyes, gums, kidney, diabetes and wounds. It is also used in treatments of fever, common colds and tetanus to overcome body aches and pain and as a blood purifier. Powdered stems of *C. fenestratum* are used in facial creams and bath tubs as an antiseptic agent. It is an active ingredient of ayurvedic shampoos, soaps, bath oils and shower oils etc. The bark and root bark have been applied for treating jaundice, leucorrhoea and other gynecological troubles as well. Matured parts of roots boiled in water are used as a tonic against colic and stomach aches (art, et al., 2013).

Non medicinal uses

In addition to medicinal properties *C. fenestratum* is used in many other ways by the local people. Tough fibers in its stem make it a suitable substitute for rope. While its slender flexible stems are used to tether cattle, large parts are used for hauling logs by elephants and in the construction of suspension bridges. The stems when boiled with water yield a deep yellow dye, which had been used in the past for dying robes of Buddhist monks as well as for traditional fabric staining in Malaysia. When tapping *Caryota urenus* (Kithul), people use the thin vine of weniwel to bind the Kithul inflorescence. A piece of Weniwel bark is used to prevent natural fermentation of sweet toddy of Kithul (Singhakumara, et. al., 2003). The world's oldest document "Dunhaung Diamond sutra", exposed from caves of China was found to be conserved by dyeing it with berberine as it is a fluorescent compound. The natural propagation of *C. fenestratum* is facilitated by orangutans, gibbons, macaques and some other birds being a part of the natural eco system as they feed on ripe fruits (Tushar, et. al., 2008).

Propagation of *C. fenestratum*

Seed propagation

Even though *C. fenestratum* is naturally regenerated by seeds, several limitations of seed propagation were recorded. *C. fenestratum* seeds can be seen once a year. The seeds have hard endocarp, show the presence of inhibitory substances and have less viability of seeds due to seed born fungi. The limited number of female plants flowered within one fruiting season were the main limitations (3 female plants to 60 male plants) (Singhakumara et. al., 2003). Since the female plant can only be identified during a fruiting season and not all the female plants produce fruits in the same season, the above study conducted only in one fruiting season may not have counted all the female plants. However, it was recorded that only around 30% of the Veniwel population will flower during a flowering season (Van and Tap, 2008).

Seeds of *C. fenestratum* showed all hallmarks of "recalcitrant" seed characters, considering their initial moisture content and moisture losses. The moisture content of fresh seeds was 31± 0.6%. The best method to conserve moisture of seeds above 25% during storage was by maintaining them in a humid chamber. The viability of seeds decreased progressively with storage time and the associated moisture loss. Forty days after storage, the highest viability (89%) was recorded when seeds were stored in a humid chamber while the least viability (30%) was recorded when seeds were stored under ambient conditions. Sixty two percent of viability was shown when seeds were put in the poythene bags and stored while the viability was 41% when seeds were put in paper bags and stored (Bandara et al., 2003). Therefore, extra care is needed to prevent desiccation during the transport of seeds from the place of collection to the nursery at the field station (Gunatilleke et. al., 2002).

It was recorded that seeds of *C. fenestrartum* having relatively long period of dormancy (40-364 days) and germination under natural conditions was less than 20%. Results of chromatographic and spectroscopic investigations of the seed resources of *C. fenestratum* after four months storage showed that the endosperm contained comparatively high percentage of carbohydrate (67.33%) and comparatively low protein (5.03%) and lipids (3.12%) suggesting that the seed could remain dormant for a long period.

The amino acid profile was nutritionally balanced and rich with the essential amino acids (Ariyarathna et al., 2001).

According to anatomical studies performed using *C. fenestratum* seeds after four months storage, the average seed coat thickness was 1.62 mm. The embryo was located deeply within the invaginations of the endospermic tissues. The thick, stony seed coat (integument) and the dry and hard endospermic tissues act as mechanical barriers to the developing embryo. The seed coat consisted of a compactly arranged lignified strongly water repellent macrosclereid layer that impedes the imbibition process (Ariyarathna et al., 2001).

Bioassays conducted using *Brassica junceae* L. to examine the presence of germination inhibitory substances in the seeds of *C. fenestratum* after four months storage revealed that the 5% water extracts from the seed coat and the endospermic tissues gave very low germination (2-5%), suggesting the presence of inhibitors compared to 80-99% germination resulting with 2% extracts, suggesting the presence of inhibitors even after 4 months storage (Ariyarathna et al., 2001; Bandara et al., 2003). Warakagoda and Subasinghe, 2015 reported that mature seeds of *C. fenestratum* (Menispermaceae) recorded 92.2% germination within 3 months after exposure of seeds to direct sun light for 6 h (sun cracking) followed by dipping seeds in 2250 mg/L Gibberelic Acid (GA3) solution for 24 h. Seeds subjected to sun cracking followed by water soaking for 24 h started to germinate 4 months after sowing and continued up to 6 months while GA3 pretreatments significantly ($P \leq 0.05$) reduce the time taken for germination from 6 months to 3 months.

The only report which ensured positive results were by reducing the initial moisture content of fresh seeds of *C. fenestratum* from 23% to 10% by exposing to open laboratory conditions which enhanced germination from 37% to 93% (Anil Kumar, et al., 2010). However, exposure to any pretreatment to break hard endocarp or to remove inhibitory substances present in endosperm, endo and mesocarp was not mentioned. It was only reported the enhancement of germination further up to 67% to 95% respectively when pretreated with 2- 10% KNO3 or GA3 3000 ppm (Anil Kumar et al., 2010) but the time of exposure was not highlighted.

Seeds kept exposed for two months at laboratory conditions lost their viability, while the seeds stored for four to six months inside the polycarbonate bottles expressed 90% germination within a month of sowing. Thus, the effect of either 10% reduction in moisture content or hermetic storage for more than three months after ripening is the same for alleviating dormancy. Therefore, it was suggested that the embryo is fully matured at the time of distribution, and the dormancy may be controlled by some other physiological factors like GA3 ratio (Anil Kumar et al., 2010).

Vegetative propagation of *C. fenestratrum*

Very few studies have been done on vegetative propagation of *C. fenestratum* Studies conducted by Gunatilleke et. al., (2002) on vegetative propagation using stem cuttings treated with 3000 mg L-1 commercially available rooting hormones such as secto (NAA), clonex (IBA) and puree NAA powder showed that success percentage was zero. He also reported that seeds treated with different hormones (3000 mgL-1 IBA or NAA) after wounding the stem near a node were not successful even after rooting. Even though several studies have been conducted on in vitro micro-propagation of this plant (Warakagoda and et al., 2017, Nair and Seeni, 2003), successful micropropagation protocol for large scale planting material production could not be found.

Cultivation of *C. fenestratum*

C. fenestratum shows slow growth rate and requires a large growing space with nearby trees to climb up to the canopy. Since no systematic cultivation or proper protocol has been developed for mass scale cultivation and as it can

easily be collected from nearby forests, people are not interested in cultivating *C. fenestratum* in home gardens. The best strategy for cultivation is to use forest margins, stream banks and natural gaps where the ideal microclimate is available for weniwel plants to grow (Singhakumara et al., 2003). There is no any literature found on cultivation protocol developed for weniwel locally or globally.

Harvesting and post-harvest handling

When required; stems, branches and roots are collected from forests. Usually stems > 1.5 cm in diameter are harvested (Singhakumara, et. al., 2003). Prior to use or sold they should be air-dried for several weeks. Since they are not subjected to insect or other pest attack, dried stems and roots can be stored for extended periods of time. Medicinal properties present in the dried parts are not subject to deterioration during storage (Tushar, et al., 2008). When preparing for use in ancient times, the outer corky rind is removed first by scraping, and then mildly beaten with wooden mallets to remove the bark which is normally not used as a medicine (Kolammal, 1978). However, nowadays the entire stem and root are cut into pieces and used.

After harvesting, new buds are regenerated from cut stems and these buds can grow into 10 m height stems with 2.8- 3.2 cm diameter within 12 years, and they can be harvested again. For regeneration, roots along with 20- 30 cm stem base are needed to be left in the ground (Van and Tap, 2008). It was reported that the stems of this highly valued medicinal plant can be harvested in the month of December when rains subside in wet zone, Sri Lanka. Short stumps are proposed to be left for coppicing by cutting off woody liana stem 50 cm above the base. According to the report mature stem parts are only taken out leaving rest in the forest and harvesting cycles are recommended to be carried out in three years (Ekanayake, et al., 2004).

References

1. Anil Kumar, C., Chitra, C.K., Bindu, S., Prajith, S. and Methew, P.J., (2010). Dormancy and germination of *Coscinium fenestratum* (Gaertn.) Colebr. Seeds. Seed Science and Technology 38(3):585-594.
2. Ariyarathna, H.A.C.K., Tennakoon, K.U., Gunatileke, I.U.A.N. and Gunatileke, C.V.S., (2001). A Preliminary Investigation on Seed Dormancy in *Coscinium fenestratum* (Colbr.) (Menispermaceae). Proceedings of the Annual Research Sessions, Universiy of Peradeniya, Sri Lanka. 6:125
3. Bandara, R.M.M.M, Tennakoon, K.U. and Gunathilleke, C.V.S, (2003). Investigation of cost effective seed propagation methods for the medicinal liana *Coscinium fenestratum* (Menispermaceae). Proceedings of International Forestry and Environment Symposium, Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Sri Lanka. p.53.
4. Ekanayake, S., Angammana, D., Fernando, S., Samarawickrama, P., Perera, N. and Perera, S., (2004). Sustainable extraction of non-timber forest products in Diptorocarp dominant lowland rain forests: a case study in south western lowland rain forest in Sri Lanka. Proceedings of the APAFRI-8th Round-Table Conference on Dipterocarps, Ho Chi Minh: Forest Science Institute. pp.15-17
5. Gunatillake, I.A.U., Gunatilleke, C.V.S., Tennakoon, K.U., Dassanayake, M.D. and Wanigasundara, W.P.D., (2002). Development of propagation techniques for medicinal plant species *Solunum album, Coscinium fenestratum, Piper longum* and *Hemidesmus indicus*. Sri Lanka Conservation and sustainable use of Medicinal Plant Project, Ministry of Indigenous Medicine and disaster relief research report MP/RP/04. Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.
6. Jayaweera, D.M.A., (2006). Medicinal plants (indigenous and exotic) used in Ceylon, Part IV. Colombo: National Science Foundation Sri Lanka. pp.70-71.
7. Kathriarachchi, H.S., Tennakoon, K.U., Gunatilleke, C.V.S., Gunatilleke, I.A.U.N., Ashton, P.M.S., (2004). Ecology of two selected liana species of utility value in a lowland rain forest of Sri Lanka: implications for management. Conservation and Society, 2:273- 288
8. Kolammal, M., (1978). Pharmacognosy of Ayurvedic Drugs. Series I. No. 2. Thiruvananthapuram: Department of Pharmacology, Govt. Ayurveda College.

9. Nair, L. G. and Seeni, S., (2003). Preliminary Studies on in vitro multiplication of *Coscinium fenestratum* (Gaertn.) colebr. (Menispermaceae). J. Plant Biol., 30(1):85-88
10. Rai, R.V., Rajesh, P.S. and Kim H-M., (2013). Medicinal use of *Coscinium fenestratum* (Gaertn.) Colebr.: an short review. Oriental Pharmacy and Experimental Medicine, 13(1):1-9.
11. Singhakumara B.M.P, Joseph M. and Mahindapala R., (2003). Kanneliya medicinal plant conservation area. Sustainability studies on selected medicinal plants species in Bibile, Rajawaka, Kanneliya and Naula medicinal plants conservation areas. Conservation and sustainable use of medicinal plants project. Report No. MPCP/R/30. IUCN Sri Lanka.
12. Tushar, K.V., George, S., Remashree, A.B. and Balachandran, I. F., (2008). *Coscinium fenestratum* (Gaertn.) Colebr. - A review on this rare, critically endangered and highly- traded medicinal species. Journal of Plant Sciences 3:133-145.
13. Van, N.D.N. & Tap, N., (2008). An overview of the use of plants and animals in traditional medicine systems in Vietnam. Ha Noi: TRAFFIC Southeast Asia, Greater Mekong Programme.
14. Warakagoda P.S. and Subasinghe S (2015). Studies on seed germination of *Coscinium fenestratum* (Menispermaceae): A threatened medicinal plant. International Journal of Minor Fruits, Medicinal and Aromatic Plants 1(1):37-46 pp.
15. Warakagoda, P.S., Subasinghe, S. and Gunasekere, M.T.K. (2017). In vitro clonal propagation of *Coscinium fenestratum* (Gertn.) Colebr. (Weniwel) through nodal explants. J. Natn. Sci. Foundation Sri Lanka 45(2):133-141 pp.

Fungi : boon or bane?

Fungi, in general, are associated with disease, most often skin ailments. However, not much is known about the beneficial uses of fungi, except perhaps in the culinary field where some mushrooms are considered a great delicacy, and other fungi are valued for the making of mouldy cheese such as blue cheese. Of course its use in beer making and bread, perhaps is the most significant and cannot be underestimated. They also provide medicines such as statins, penicillin and immuno-suppressant drugs which have several uses both in medicine and industry.

Recent research has now revealed, that certain fungi have a huge potential in mitigating some of the worlds biggest challenges such as providing clean fuel and breaking down plastic wastes. The fungus responsible found in Pakistan, has shown to be capable of breaking down plastics such as polyester polyurethane in weeks rather than in hundreds of years. This is indeed an effective breakdown in terms of solving a global problem. This research has been carried out in the Royal Botanic Gardens , UK.

Another discovery has revealed that fungi living in plants are capable of breaking down molecules in plants cells directly into chemicals with similar properties to diesel. With the fervent search for bio fuels this could also be an astounding breakthrough. Fungi grow around roots and help the plants to absorb more water and nutrients, helping in plant growth. Some fungi can grow in extremely acidic conditions, and are able to tolerate high levels of gamma radiation and this property could be made us of in cleaning up radioactive waste sites.

Not withstanding these findings, compared to plants and animals, little is known of the over three million species of fungi identified. Many of these could already be under the threat of extinction as a result of habitat loss and other environmental changes, but only 56 species have had their conservation status assessed for the IUCN Red List of threatened species as against over 25,00 plants and almost 60,000 animals.

A learned professor once described fungi as Jekyl and Hyde , because although they are important in several aspects of life they can also be the most devastating organisms to life on earth.

Extracted from From Sunday Times, September 16, 2018

PRODUCTS FROM LINK NATURAL

MULTIPLE BENEFITS OF 100% NATURAL "PINDA OIL"

By Madhavi Watson

Ayurveda is the ancient science that dealt with all aspects of human life, be it healing the body or the mind. The 5000 year old magic of the Ayurveda Physicians has withstood the face of time and today it is one of the most effective and safe healing practices that is gaining popularity and acceptance across the globe.

Pinda oil is a unique oil with amazing, multiple benefits. It is particularly useful in skin conditions arising from *"Vatha Raktha"*. It is also useful in inflammatory conditions of the tendons and joints.

Pinda oil for Rejuvenating the Skin

This herbal oil is beneficial for multiple skin problems. It is commonly used to ease itching and burning sensation of the skin, dryness of the skin, skin rashes, cracking of the skin of the sole, burning sensation of the palm and sole and discoloration of the skin.

Other uses

It has wound healing properties and is also useful in arthritis, sprains and myalgia.

Pinda oil manufactured and Marketed by Link Natural Products (Pvt) Ltd contains the following ingredients.

Herbal Ingredients used are dried stem of *Glycyrrhiza glabra* L. (Liquorice / welmee), dried stem of *Hemidesmus indicus* (L.) R.Br. (Indian sarsaparilla/Iramusu), dried stem of *Rubia cordifolia* L. (Indian Madder – Welmadata) and resin of *Vateria copallifera* (Retz.) Alston (hal). Other ingredients are Ghee, Sesame oil and Bee's wax.

Resin of *Vateria copallifera* (Retz.) Alston

Dried stem of *Hemidesmus indicus* (L.) R.Br.

Dried stem of *Rubia cordifolia* L.

Dried stem of *Glycyrrhiza glabra* L.

The pictorial input by Ms. Sachini Ranasinghe is gratefully acknowledged.

"LINKING" WITH PEOPLE AND SOCIETY

DONATION OF HANDWASH UNITS TO SCHOOLS

By CSR Department

"Link Natural Educational approach" is a project that Link Natural implements as a part of its CSR programme to create a talented student body by improving the education and skills of children in the selected 12 schools in the Dompe area.

According to the COVID-19-related public health requirements as instructed by the Health Department, Students had to follow strict Covid-19 health guidelines with the reopening of schools. Therefore, there was an urgent requirement for handwashing units for school children. To fulfil requests which came from the schools for hand wash units, the Engineering & Maintenance division of Link Natural Products set up 12 hand wash units with the proper standard and donated to the schools that are associated with the CSR project.

Donation of Handwash units to Schools

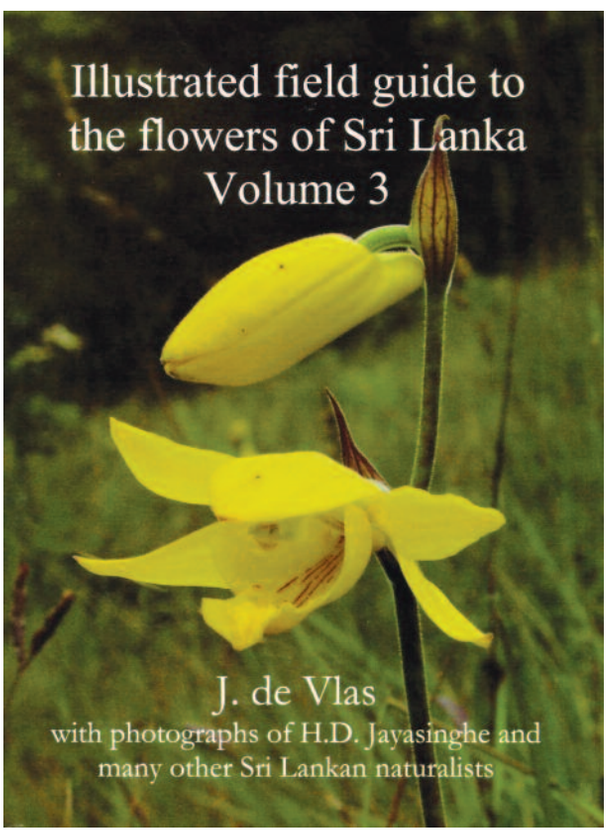
AVAILABILITY OF LINK PRODUCTS

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														✓		✓

BOOK REVIEW

ILLUSTRATED FIELD GUIDE TO THE FLOWERS OF SRI LANKA, VOLUME 3



Book : ***Illustrated Field Guide to the Flowers of Sri Lanka, Volume 3***

Authors : *Jacob de Vlas (Author), Himesh Dilruwan Jayasinghe (Illustrator)*

ISBN : *9789082313413*

Publisher : *Jacob De Vlas, The Netherlands*

Paperback : *320 pages*

The author of this book, Dr. Jacob de Vlas and his wife Johanna de Vlas-de Jong have been visiting Sri Lanka since 1977. In 2008 and 2014 they published volume 1 and volume 2 of the Illustrated Field Guide to the Flowers of Sri Lanka. Together, these books cover about 1960 plant species of Sri Lanka, with emphasis on herbs and shrubs because all flowers were photographed below about 2 m above ground level.

This third volume deals with 1067 plant species of which 967 were not described in Volume 1 and 2. Many of them are rare, and some are probably new to the flora of Sri Lanka or even to science. Approximately 87% of all pictures in Volume 3 were taken by Sri Lankan naturalists or photographers. Himesh Dilruwan Jayasinghe was the main contributor with 63% of all photographs.

By publishing this last volume in a series of 3, the author, his wife and all photographers wish to contribute to the spread of knowledge of Sri Lankan plants among nature lovers, students and professionals, and indirectly to the conservation of the flora of Sri Lanka.

https://www.nhbs.com/title?slug=illustrated-field-guide-to-the-flowers-of-sri-lanka-volume-3-book

DIGEST MAIL BOX

Letter 1

I received the Link Natural digest volume 15 and was very happy to see that Link has opened world class R&D centre. Also, specially to note that Dr. R.O.B. Wijesekera has opened the facility. Please give my best regards to Dr. R.O.B. I always read with keen interest the article and research papers.

Wishing you and your team at Link all success in future endeavors.

Mr. B. Sarada M. De Silva
Chairman
B. Darsin De Silva & Sons (Pvt) Ltd
Exporters of quality Pure Ceylon Cinnamon

Letter 2

I would like to receive a copy of the Lanka Natural DIGEST, which I found has some interesting reading matter.

Thank you. Suresh

Response
Your mailing address will be added to our Link Digest Readers data base. Several copies of the publication will be posted to you as soon as possible.

Please find the below link to the Link Digest PDF files.
http://linknaturalproducts.com/knowledge-base-publications/

Letter 3

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National Library and Documentation Services Board

Letter 4

The Library, University of Jaffna gratefully acknowledges with thanks the receipt of the under mentioned publication donated by you. We are sure this donation will enrich our library collection and support the teaching and learning activities of the University.

We appreciate your concern towards the development of our Library. The University community is grateful for your good will.

University of Jaffna

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.

Potential authors may consult the Editor-in-Chief prior to dispatch of communications, reports and reviews.

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