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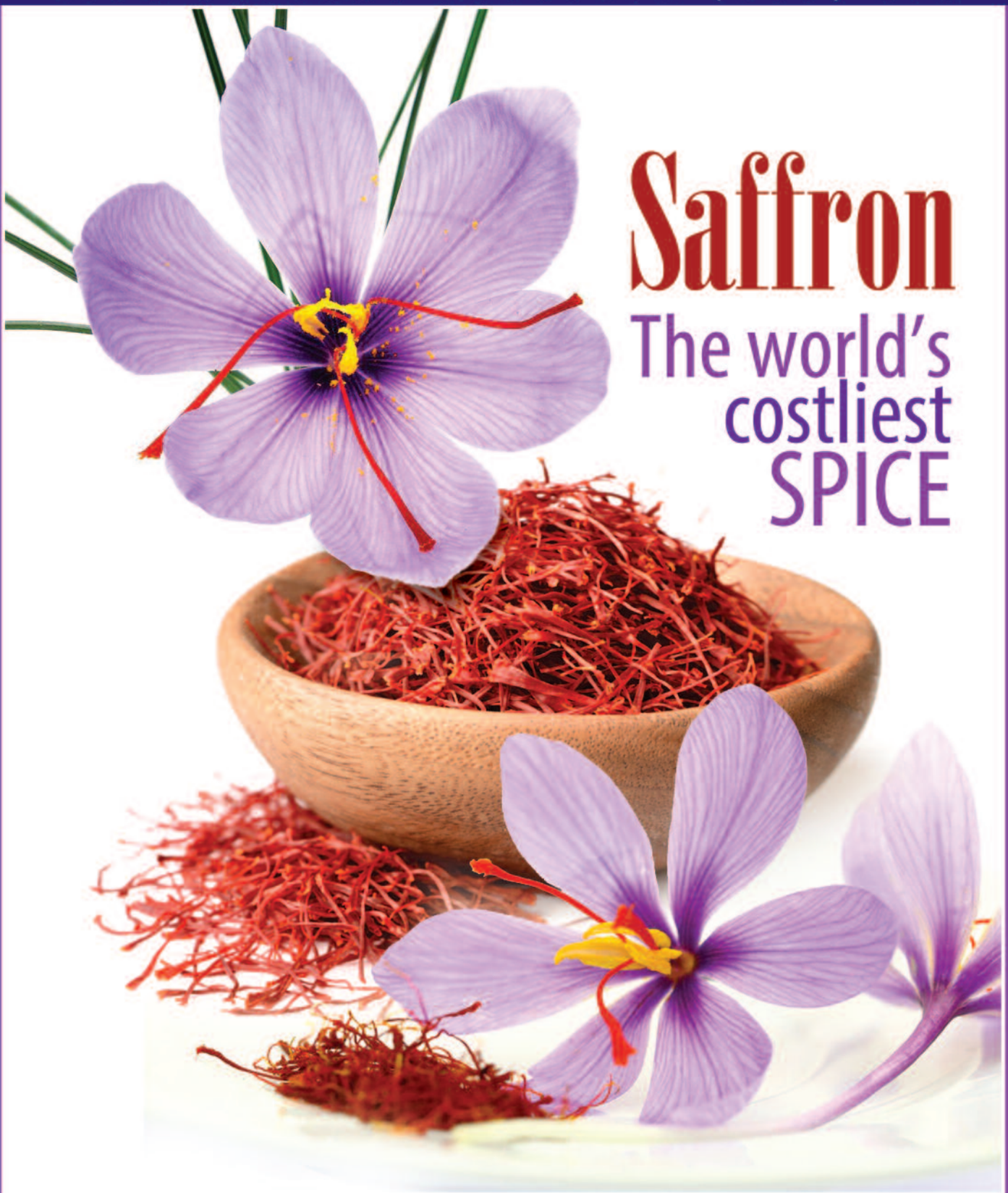

Saffron

The world's costliest SPICE

Link Natural DIGEST

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IN THE PAGES THAT FOLLOW.....

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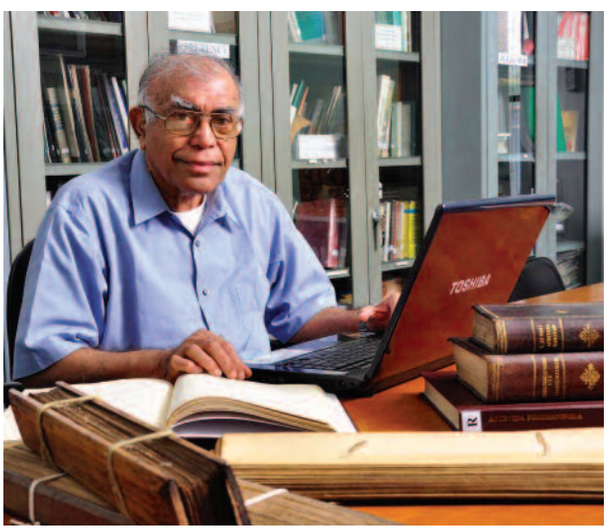
EDITORIAL



There is the old story of the legendary little Dutch boy who saved his country from a catastrophic flood by sticking his finger to block a leak in the dyke. It a story written by Mary Marples Dodge in 1866, and the boy is identified as Hans Brinkler.

This old story strongly reminds one of the role missed out by the global science of our recent days. With the onset of the deadly virus, now named Covid, we found the world virtually paralysed by its potential danger.

Alarmingly, global science had naught to offer for our comfort. The world's population was left to depend on the simplest of defences. There was no little dutch lad to save the global community. Whereas global science has been a major spender of the world's money it was found to have no ready response to combat the new danger of the deadly virus. It so happened that resources had not been channelled in the direction of the safety of mankind in a sufficiently potent fashion, instead it would seem that more spectacular issues appealed to the major research agencies. International competition between the political powers that dictate these things would be a cause.

The time has come to reverse these despicable trends. Let the resources of the globe redirect instead towards its own welfare and sustenance. Things like speculative interspatial travel can take a back seat. There is so much to be done, just within land, air, waterways and oceans. This is a clarion call for the immediate re-orientation of our global research priorities

There is no time to linger.

R.O.B. Wijesekera

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SAFFRON – THE WORLD'S COSTLIEST SPICE

R.O.B. Wijesekera and Keara De Silva *

Preamble

Saffron is a unique product of the vegetable kingdom as it can be used as a spice, a colorant, a flavouring and has health-giving characteristics. Its features were well known to the ancient Greeks and documented in those times. It was known to the ancient Persians as well and its home even as at the present time is Iran. The country is still the world 's major source of this most valued spice.

Commercial Saffron, is the collection of dried stigmas of the flowers, and it has been used in folk medicine and as a food additive in the days of the ancient Greek civilization and its value was high at all times due to its rarity. Its documented use spans 4000 years and said to be effective for about 90 diseases. *Crocus sativus*, therefore, boasts a colourful history, a vivid botanical scenario, as well as a profitable use to humankind. Counted as a spice, as it is sold as such, it is the most valuable of them all.

The world's annual production is estimated at around 200 tonnes where over 80% of the production is located in Iran and Spain. There are now several other producer countries due to the commercial importance of the product but the economic viability of the production is largely dependent upon climatic factors and cultivation practices. Today the plant which generates the real saffron is found cultivated in the Kashmir region in India and elsewhere, in Spain, but Iran remains the major world producer. Thriving in mild and dry countries, *Crocus sativus* can also be found in Greece, Morocco, Italy, Turkey, Pakistan, Azerbaijan, China, and Egypt.

Historical Aspects

In the Achaemenid times, saffron was used as a food or spicy plant product.

With the spice's extreme popularity during 14th century Europe, 363 kilograms of the

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spice was stolen off a ship, sparking a 14 week long 'Saffron War.'

As a consequence, to this, In the 15th century, in Nuremberg the Safranschiou Code was enacted to make saffron adulteration executable. Unscrupulous traders, adulterated the saffron by soaking in honey, or mixing with marigold petals or keeping in damp cellars, to add to the bulk of the products. To put an end to this, the Safranschiou code, was passed to de-louse the saffron trade and adulterators were thus fined, imprisoned, and executed by immolation.

Different species of Saffron

Across Mediterranean Europe and Western Asia, 85 species of the *Crocus* genus exist. These include *Crocus sativus, Crocus chrysanthus, Crocus sieberi and Crocus vernus.* These species are obtainable in several colours; they come in pastels, blues, violets, yellows and creams. Whilst these plentiful species exist, only approximately 30 have been cultivated.

Botanical Features

Crocus sativus Linn., is a grass like tuber plant with purplish or lilac coloured flowers. Its flower stalk rises from a bulb and has a slender white tubular shape with an attractive lilac colour. The leaves are radical dark green, enclosed in a membranous sheath, sometimes remaining fresh the whole of the winter. The corolla is in two segments between which the long styles hang out. A part of the Iridaceae family, the flowering plant *Crocus sativus* comprises of three yellow stamens and three crimson stigmas stretching out over the purple petals. The three large stigmas are bright orange in colour, and these are parts of the plant which impart a great value to the plant. Typically open during the daytime, the flower closes during the night time and on cloudy or rainy days. Blooming in typically 4 to 10 weeks, the plant's height reaches from 10 to 15cm. With a strong odour, saffron retains a bitter taste.

In Indian medicine both the great physicians of yore, Susrutha and Charaka, had used this plant and that is how its identity if at all, with the totally unrelated plant of the Zingiberaceae species came about. Both these plants have a strong yellowish pigmentation though totally different. One grows from a root while the Crocus species is propagated from a bulb which is planted into the soil. They both have similar uses both traditional as well as medicinal but the differences in costs due to cultivation practices as well as availability are formidable.

Crocus sativus plant and flowers

Cultivation Conditions

These flowering plants flourish best under well drained soil, at an optimal temperature from 23 to 27 °C and 4 inches deep in the soil. As the plants do not store well, the plant bulbs should be planted almost immediately after obtaining them. They also do not grow well in frost. When placed in warm weather or exposed to sunlight, the plant can potentially shift in colour and odour. However, Crocus genus plants have large potential for adaptation, tolerating a variety of geographical conditions.

Production of commercial Saffron

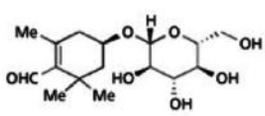
Traditionally, the stigmas from saffron were dried by tying them to the ceiling at an appropriate temperature. At present times, electric ovens are used. When making the saffron spice, 75,000 saffron flowers are used because the part of the *Crocus sativus* that makes the spice is only a minute part of the flower. Further, saffron harvesting is manual. The saffron must be harvested with the flowers closed during mid-morning in order to preserve the plant's stigma. If flowers on the *Crocus sativus* fail to be opened on the same day as harvesting, the saffron quality will be compromised. A combination of these two factors manifests in the spice's expensive cost.

An outdoor saffron field

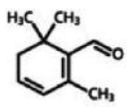
Chemistry of Saffron

The contents of Saffron have been investigated since ancient times due to the economic importance of the product. It has been recorded in the Materia medica of Pedado Dioscorides, and known thereafter in the literature of medicinal and aromatic plants.

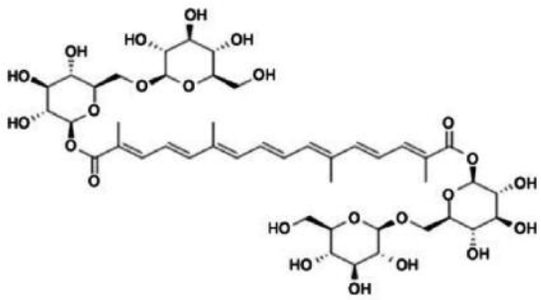
The chemistry of saffron is dominated by those agents that are responsible for colour and flavour. The therapeutic qualities come within the dominant chemical constituents which all belong to the chemical class of "Terpenoids" The major constituents are: picrocrocin, safranal, crocin and crocetin.



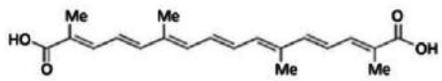
picrocrocin



safranal



crocin



crocetin

Health Benefits

The following health benefits are attributed to the intake of Saffron, but the veracity of these claims remain to be authenticated.

Acts as an Antioxidant – Saffron comprises of a range of plant compounds, through which it has significant antioxidant properties, preventing free radicals and oxidative stress from harming body cells.

Prevents Cancer growth - With antioxidant properties and cancer linked to free radical damage, saffron observably kills or averts cancer cell growth. This includes cancer cells in the colon, skin, bone marrow, prostate, lung, breast etc.

Reduces Depression - As a means of treating mild to moderate depression, this spice is equally successful in comparison to conventional antidepressants (Fluoxetine, Imipramine) and more effective than placebos. Further beneficial anti-depressive properties have been linked to saffron petals and stigma.

Mitigates Anxiety – Studies have shown that, when compared to a placebo tablet, 50 mg of saffron over twelve weeks helped to reduce anxiety

Reduces Premenstrual Syndrome - Saffron potentially retains benefits in reducing symptoms evoked by premenstrual syndrome. This includes irritability, headaches, craving, pain and anxiety.

Acts as an Aphrodisiac - It has been recorded that 30 mg of saffron over a month have been recorded to assist libidio, reduce sexual pain and improve erectile function in both men and women.

Suppresses Appetite - Whilst the method through which saffron does this is unknown; the spice is said to prevent unwanted eating by hindering the desire for individuals to snack.

For Treatment of Coughs / fevers - When saffron is mixed with milk, it can be applied to the forehead to act as a stimulant tonic and thus assists to alleviate colds, coughs and fevers.

Acts as a Memory aid - Crocin, a carotenoid chemical compound that can be extracted from saffron, has shown to have benefits in learning and memory as individuals age.

Increases cardiovascular Health - A study where individuals over 3 months ingested 100 mg of saffron, revealed decreased antibodies from heat shock proteins, thus increasing cardiovascular health.

Reduces Age Related Macular Degeneration - A potential use can be revealed in age-related macular degeneration (AMD) as certain vision supplements comprise saffron. A study showed 30 mg of saffron over six months improved visual function for dry and wet AMD.

Reduces Insomnia - With mild sedative properties, saffron is said to assist in the treatment of insomnia by inducing calmness and hence increase the ability to sleep.

As a Vitamin supplement - Saffron is a spice filled with plentiful vitamins crucial to improving health. This includes vitamin-A, folic acid, riboflavin, niacin, and vitamin-C.

Has Anti-inflammatory properties - Once more focusing on its antioxidant properties, the saffron extract called crocin inhibits inflammation. Specifically, the inflammatory molecules TNF-alpha and interleukin-6.

Traditional Health Aspects

As mentioned, for over 4000 years, saffron has been used to treat more than 90 illnesses. From the 16th to 19th centuries, saffron was used for pain relief in opioid (a medical drug) preparations. Specifically, laudanum (a solution of opium) contained opium, saffron, cinnamon, and cloves. Saffron was also used in traditional herbal medicine as a sedative, expectorant, and anti-asthma agent.

In Ayurveda

In the traditional Hindu Ayurveda Health System, saffron was said to provide nourishing properties. Acting as a cooling blood purifier, the spice assisted with ailments concerning blood stagnation. This includes inflammation, arthritis, and acne. Further, it was used as a skin and reproductive tonic, a mind

refrigerant and as a purifier of the urinary tract when taken in a mixed dosage.

In Persian Medicine

Notably used in Persian Medicine, the Persian polymath Avicenna's 1025 The Canon of Medicine indicates saffron's several healing benefits. The book describes its use as an anti-depressant, hypnotic, anti-inflammatory, hepatoprotective, bronchodilatory and aphrodisiac. Namely, Cyrus the Great used saffron threads in his bathing water, intended to revitalise his body and heal battle injuries.

In the Asian Region

In Asia's tropical region, there was documentation of a soothing lotion applied to dry skin, which was comprised of sandalwood and saffron. As an antioxidant, saffron inhibits harmful molecules such as free radicals that damage healthy skin cells.

In Ancient Greece

Ancient Greek physicians, including Hippocrates, Erasistratus, Diokles and Dioscorides, revered saffron for their soothing effects. Hippocrates's writing reveals application in namely eye disorders, earache, toothache, ulcers, coughs, colds, stomach ailments, scarlet fever and more.

In Ancient Rome

In Ancient Rome, saffron relieved coughing and mixed with wine was deemed a cure for hangover. Further, Roman John Gerarde's 1597 The Herball, describes saffron's use to treat the bubonic plague, which was a pandemic in Europe from 1347 to 1351.

In Iranian Medicine

In Iranian Medicine saffron was used to improve physical and spiritual health. On the physical side, it was used for headaches, insomnia, eye issues and decreasing appetite. In considering its spiritual properties, saffron was found in incense and scented oils for important community figures.

In Chinese Medicine

Referenced in Ancient Chinese texts, saffron was used as a spiritual antidote to remove harmful 'qi' (the energy of the body in Chinese philosophy) and demons in the body.

Economic Aspects

One of the biggest problems besetting the avid saffron user, are the adulteration practices employed by the producers. This is done to decrease the extremely high cost of saffron in its pure state. The spice is commonly mixed with beet, pomegranate fibres and red dyed silk fibres. Another adulteration technique is that yellow saffron stamens are mixed with saffron stigma or powder in order to increase product mass. Other flowers are also sometimes mixed with genuine stigmas, as also artificial colorants.

It is thus imperative that strict quality control measure is put in place to ensure that genuine saffron is available in the market. To maintain the authenticity of saffron codes are now used.

The annual production of saffron was a little over 400 tons per year in 2018 showing an significant increase within the last ten years. Of this, as mentioned, over 90% is from Iran. Around ten years ago, Iran and Spain shared over 80% of the production. It is interesting to note that 28 g can cost around $ 30, and 500 g can be obtained from 200 000 stigmas. This means that 500 g costs around $ 530, which is a steep cost.

Saffron field in Spain

Conclusion

Throughout history, Saffron has held a unique position as a spice, additive, flavourant, colorant and a significant health-giving agent. Care must be taken to preserve these attributes and prevent the adulteration of this material which will then dilute the effects and may even prove to be harmful. It will also be beneficial if the cost of this valuable condiment could be maintained in such a way as to make it available to the average consumer, as presently the cost is prohibitive to most consumers.

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JAK FRUIT SEEDS : CAN IT YIELD A POTENTIAL CHOCOLATE FLAVOUR ?

By Dilmani Warnasuriya

The Jak fruit tree

The Jak fruit is a tropical fruit of the jak tree which is a species of the Artocarpus genus belonging to the family Moraceae . The tree is native to India, Thailand, and Indonesia and is also now found in many parts of Asia, Africa, South America, and northern Australia. It grows well in warm and moist regions. (see Link Digest Vol.10, Issue 1 for details)

Jak fruit tree

Jak fruit is a popular food among Sri Lankans both in towns and villages. However, most urban housewives are loath to use it as a vegetable, due to the tiresome process of cleaning the fruit. Like all other parts of the tree, the fruit exudes a sticky, milky white latex which is not washed off easily, but needs an oil for the purpose. Fortunately, cleaned fruit and seeds are often available fresh in the markets, and also canned.

Unripe Jak fruit

Canned Jak fruit products

The jak tree is a multipurpose species somewhat akin to the coconut tree where almost all parts of the tree could be put to use. The trunk of the tree provides a strong timber for building, dying, carpentry and as a fuel and the entire fruit can be used as food and also for therapeutic purposes. The starchy consistency of the fruit makes it a substitute for rice, and is eaten with a spicy sambol especially in rural areas when rice becomes an expensive commodity. Probably due to this, the Jak tree is also known as the poor man's tree. The tree is usually grown in home gardens, and is a good source of income for the householder. The tree enjoys a long-life span which can go up to 70 years.

The fruits are said to be the largest tree borne fruits in the world, the smallest fruit weighing from 2k – 7k and the largest more than 45k. Each tree can bear around 250 fruits per year, and although generally seasonal in bearing fruits, many Asian countries bear fruits all year round. The fruit may contain between 100 and 500 seeds which represents 18–25% (db) of the fruit weight while the pulp represents 30% of the fruit.

Ripe Jak fruit

Raw Jak fruit seeds

A brief look at the fruit itself, the fruit is covered with blunt thorn like projections which flatten as the fruit ripens. The inside of the fruit consists of over 100 cream coloured edible bulbs packed within thin bands of fibre. Within the bulbs lie a smooth oval light brown seed, which is our focus of interest. While the bulbs of both the ripe and unripe jak fruits are eaten in various ways, jak fruit seeds are an under-utilized waste in many tropical countries, and is considered to be an agro-industrial waste.

Jak fruit seeds

As described, the seeds lie within the bulbs of the fruit and its shape varies from oval to round. They are 2-3 cm in length and a little over 1cm in diameter and light brown in colour. A single seed is enclosed in a white aril encircling a thin brown spermoderm, which covers the fleshy white cotyledon. Jak fruit cotyledons are fairly rich in starch and protein

The seeds of a ripe fruit have a moisture content of around 55% and therefore do not keep well for long. In Sri Lanka, the seeds are eaten boiled, roasted, fried or curried. It is also interesting to note that the roasted seeds are also made into sweetmeats, desserts and in confectionery, giving an insight into the foresight of our fellow countrymen in identifying the potential of the seeds for such use. But by and large one could classify this as an underutilized waste. With many scientific studies presently in progress on the utilization of under-utilized wastes, jak fruit seeds also have come under focus in many of these studies.

Interest on the jak fruit was first aroused on the potential of the seed as a source of starch for industrial purposes, the seeds having a considerable amount of starch, dietary fibre, proteins and vitamins. This was due to the industry demands being high in recent years, and there being a search for alternative sources, particularly using Agro industrial wastes. The Jak fruit seed starch can withstand thermal and mechanical shear and therefore is suitable in food formulations in industry. The seed starch has high swelling power and solubility and can be utilized as a thickener and stabilizer in food products. However, there is not much widespread use of it in industry at present, due to seasonality, difficulty in conservation, low consumption due to a high sensory intensity of taste and aroma in addition to an association of jak fruit with poor communities.

Table 1.
Proximate composition of jak fruit seed flour

PROPERTY	VALUE (% DRY MATTER)
Moisture	6.09 ± 0.01
Crude fat	1.27 ± 0.01
Ash	2.70 ± 0.02
Protein	13.50 ± 0.06
Fibre	3.19 ± 0.01
Carbohydrate	79.34 ± 0.06
Energy(kcals/100g)	382.79 ± 1.20
pH	5.78 ± 0.01

Table 2.
Minerals composition of jak fruit seed flour.

MINERALS	VALUES(mg/kg)
Calcium	3087 ± 166
Magnesium	3380 ± 388
Iron	130.74 ± 12.37
Zinc	<0.01
Potassium	14781 ± 256
Manganese	1.12 ± 0.11
Copper	0.45 ± 0.89
Sodium	60.66 ± 2.01

Source: Ocloo and others (2010)

The reported values for the nutrients in jak fruit seed seem to vary somewhat in the different studies. These variations can be attributed to the differences in source, variety, environment, and ripeness of the fruit. Nevertheless, it is indisputable that the seed is a fairly good source of starch and protein, and mineral nutrients.

The next attention-grabbing discovery on the potential use of jak fruit seeds was when bread baked with jak fruit seed flour emitted a strong chocolate aroma. Although this was an 'eureka' like accidental discovery, much excitement was aroused among scientific research circles, and several studies were launched, initially in Brazil. The most significant study was when roasted jak fruit seeds was used as a substitute for cocoa powder in making cappuccinos. According to this study, fermented and roasted jak fruit seeds can replace between 50 and 75 per cent of the cocoa that is blended with milk and coffee to make cappuccino, without affecting its flavour or aroma. The results of detailed laboratory studies giving rise to this postulate, is given in PLOS ONE, a peer-reviewed open access scientific journal published by the Public Library of Science. This gave rise to the suggestion that roasted jak fruit seeds could be used as an alternative to cocoa in chocolate making as well. Compounds found in jak fruit seeds were shown to produce many of the same

aroma chemicals as processed cocoa beans and are a potentially cheap and abundant substitute for use in chocolate manufacturing.

Chocolates and Confactionery

This suggestion was most welcome to chocolate manufacturers where, the production of cocoa was fast becoming insufficient to meet the burgeoning demands of industry. Globally, around 4.5 tonnes are produced annually, Ivory Coast being the main producer, followed by Ghana, Indonesia, Ecuador, Cameroon, Nigeria and Brazil. The suggestion that jak fruit seed could bridge the gap between supply and demand of cocoa beans was taken up by researchers and suppliers with alacrity.

Studies then commenced on the processing of jak fruit seeds for the production of chocolate flavoured flours. In these studies, much attention was paid to post harvest pre-treatment and roasting of the jak fruit seeds as this was thought to be crucial in the production of the chocolate flavour from the fruit. Conditions akin to the processing of cocoa beans was used in determining the optimum conditions under which the flavour could be produced. Thus, different roasted jak fruit seed flours were made from different cultivars by acidifying or fermenting the seeds prior to drying. These flours were roasted for various times and temperatures using processes similar to those used to enhance the chocolaty flavour of cocoa beans.

Roasted Jak fruit Seeds

It was found that fermented seeds with moderate roasting gave an agreeable flavour. But to obtain the best flavour, jak fruit seeds needed a much longer time of fermentation than the cocoa beans. A significant and positive influence of fermentation and acidification was observed in the production of the chocolate aroma. To obtain a colour and luminosity of cocoa powder, the highest temperatures used were recommended. The ten important aroma components necessary to obtain the chocolate aroma, including 2,3-diethyl-5-methylpyrazine and 2-phenylethyl acetate, were identified in the volatile components detected from the flours giving rise to much enhanced research activity in the scientific arena. The main final volatile composition in jak fruit seeds included pyrazines, Strecker aldehydes, alcohols, esters and furanes. This suggested that these esters and alcohols contributed to the sweet and fruity aroma. Moisture, pH, luminosity and color were also monitored to ensure that these properties were similar to cocoa powder or cocoa substitutes.

Conclusion

While several more studies need to be carried out to determine the commercial viability

of substituting jak fruit flour for cocoa powder, the concept itself sets the tone for more innovative studies on using unexplored waste products for the production of usable commodities. Such studies gives an impetus to arousing the interest of true research scientists. The rich tropical flora taken so much for granted and used for ornamental purposes or food, could prove to be treasure trove of valuable chemicals which could be exploited for use. Many of our day to day products used for medicinal, cosmetic and other purposes are also a result of such research activity and it is our hope that we are able to titillate the interests of our scientists by providing possible areas for their focus.

The pictorial input and the referencing by Ms. Nadeesha Gunasekera is gratefully acknowledged.

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Try not to become a man of success but rather try to become a man of value.

-Albert Einstein 1879-1955

IS MANIOC A MAGICAL TREATMENT FOR CANCER?

*By Anura Senaratne**

Cassava (*Manioc Esculenta* Crantz) is a woody shrub belonging to the spurge family, Euphorbiaceae. The plant is native to South America, but now grown in many parts of the tropical and subtropical climates of the world. Cassava probably was first cultivated by the Maya in Yucatan peninsula in Mexico. The robust nature of the plant to survive under adverse environmental conditions makes it an important crop for food security in many developing countries. The carbohydrate rich, low in protein storage roots represent an important energy source and staple food for more than 500 million people throughout tropical Africa, Latin America and parts of Asia[1]. Manioc has become the major constituent of the staple diets among many parts of the African subcontinent. Depending on the region of growth cassava is also known as manioc, yuca, macaxeria, mandioca and apim. To Sri Lankans it is manyokka.

Freshly dug manioc

Boiled manioc

Manioc plantation in Sri Lanka

Manioc is grown for its tuberous roots from which cassava flour, breads, tapioca, a laundry starch and an alcoholic beverage are derived (Indian tribes in South America make a ceremonial drink, kasiri). There are two main varieties of manioc, bitter and sweet. The value of manioc as a food is well established and people the world over have used it for the past few centuries and are still using it.

The dawn of this century accentuated the public interest in healthy foods. Informed consumers are now ready to pay higher prices for organically grown produce. Farmers welcome this trend since they receive a higher income by growing organic produce. Moreover, the health-conscious consumers are often concerned about the analytical data of the food they consumed. Hence, due to the popular consumption of manioc, much interest is shown by researchers in studying its health benefits.

Health benefits

Tapioca starch is gaining attention as a source of gluten-free flour to make bread and other baked products that are suitable for people with an intolerance to gluten.

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Manioc is a source of 'resistant starch', which boosts gut health by nurturing beneficial gut bacteria. Unlike regular carbohydrates, resistant starches remain relatively unchanged as they pass through the digestive tract. Thus, manioc provides a fulfilling meal without adding extra calories and now is used as a dietary supplement in many weight-watching programs.

Nutritional value of Cassava

Component	Root tubers	Leaves
Moisture %	62.8	74.8
Energy (Kg/100g)	580	-
Protein %	0.53	5.1
Starch %	31.0	-
Sugar %	0.83	-
Dietary fiber %	1.40	-
Ash %	0.84	2.7
Minerals (mg/100g)		
Ca	20	350
P	46	56
Mg	30	-
K	302	-
S	6.4	-
Fe	0.23	218
Vitamins (mg/100g)	Trace	3
Vit. A	0.05	0.2
Thiamin	0.04	0.3
Riboflavin	0.6	1.5
Nicotinic acid	15.0	200
Vit. C		

Source: Bradbury and Holloway, 1988, HORDI publication, Dept. of Agric. Gannoruwa, Sri lanka.

Because manioc plant was introduced to Sri Lanka by the European colonizers, manioc has not been included in the traditional medical therapies such as Ayurveda, by the native physicians. However, manioc was used as a treatment for cancer in folk medicine for decades. At the same time, Manioc was also known for its adverse effects such as cyanide poisoning in some cases. The presence of cyanogenic compounds in manioc was known and the indigenous people had developed a complex refining protocol to remove the poison by grating, pressing and boiling the tubers prior to consumption. The manioc tubers were boiled in open containers to release poisonous gases if any. The tribal people in South America and Indonesia used this poison, hydro-cyanic acid for darts and arrows.

Laboratory studies

Recently, the public media highlighted the anticancer claims of manioc resulting in renewed interest in manioc as a treatment for certain types of cancer (prostate, cervical, colon etc). Laboratory studies revealed the presence of two cyanogenic glucosides, linamarin and lotaustralin[2] in manioc. These are hydrolyzed by linamarase, a naturally occurring enzyme present in manioc, to release hydrogen cyanide. Cyanide poisoning cases related to manioc were attributed to these cyanogenic glucosides. The broad classification of manioc into sweet and bitter signifies the absence or presence of toxic levels of cyanogenic glucosides respectively (the sweet variety can produce as little as 20 mgs of cyanide/kg of fresh roots relative to the bitter variety which produce more than 50 times as much 1 gm/kg)[3]. Although manioc has been used for treatment of cancer in folk medicine, no proper scientific investigations were conducted to confirm the claims. There are laboratory research programs in progress to evaluate the anticancer properties of manioc. This anticancer property is also believed to stem from the cyanogenic compounds it contains, linamarin and lotaustralin. Linamarin is the major cyanogenic component (93%) relative to lotaustralin (7%). Linamarin, belonging to a group of chemicals called nitrilosides, hydrolyses readily by the hydrolases present in the animal cells to release cytotoxin HCN. The cytotoxic effect of linamarin was observed and recorded (cytotoxic effects on MCF-7, HT-29 and HL-60

cells lines were well established using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. Presence of endogenous enzyme linamerase (β-glucosidase) hydrolyses the cyanogenic compounds to release HCN to effect the cytotoxicity (Figure I).

Cyanide is a potent cytotoxic agent that kills cells by inhibiting cytochrome oxidase of the mitochondrial electron transport chain. But when ingested cyanide activates the body's own mechanisms of detoxification resulting in the transformation of cyanide to harmless thiocyanate[4,5]. Detoxification pathway of cyanides is catalyzed by a liver mitochondrial enzyme 'rhodanase' which is highly specific in its action.

Cancer cells get affected the most by the cytotoxin because cancer cells are almost completely deficient of detoxification enzyme rhodanese. Normal cells which are rich in detoxification enzyme rhodanese escape the toxic effects of cyanide[6].

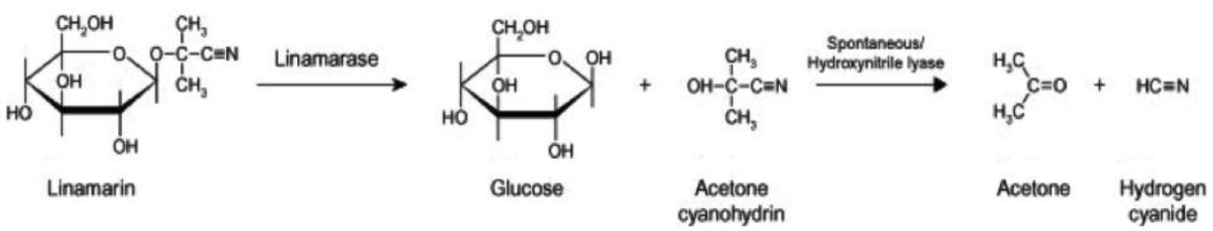

Figure I

Incidentally, a case report published by a group of doctors in Sri Lanka disputed this claim[7] of the anticancer property of manioc against prostate cancer. However, the proponents of manioc for cancer treatment dismissed this case study report, stressing that results of one case study was insufficient as evidence to test the validity of a hypothesis.

Anticancer properties of manioc came into the limelight due to parallels drawn from the activity of the bitter apricot seeds[8]. Amygdalin, a natural glycoside present in the bitter apricot seeds is metabolized by the enzyme β- glycosidases to release cyanide to kill the cancer cells ("Healing Foods" by DK Publishing). Linamarin is a member of a class known as β-cyanogenetic glucoside chemically related to amygdalin (Figure II). The modality of releasing cyanide from amygdalin to 'kill' malignant cells is similar to the cyanide release from linamarin[9]. In animal models amygdalin inhibit tumor promoting effects of Epstein-Barr virus. Some claim amygdalin to be a vitamin (B-17) and the deficiency of which promotes the development of tumor cells. This claim however is not backed by experimental evidence.

Linamarin is not toxic itself and is an unlikely a source of cyanide in the human body[10]. Linamarin has never been used in cancer metabolic therapy but the use of amygdalin and linamarin derived from seed of bitter apricot seeds for some forms of cancer control[8] (though not adequately proven scientifically) has been in practice with Chinese herbal medicine[11]. The human body is equipped with a detoxification mechanism to curb any cytotoxicity caused by hydrolysis of nitrilosides. As described above, the principal detoxification pathway of cyanide is catalyzed by a liver mitochondrial enzyme, 'rhodanase' (sulphur transferase). It is limited not merely to nitriles but to those nitriloside which surrender free HCN ions upon hydrolysis such as linamarin[12].

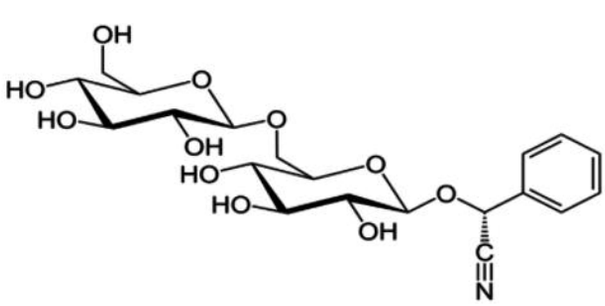

Figure II

There has never been anything to suggest the possibility of any cumulative toxicity arising from the cyanide ion itself. Evidently, the nitriloside CN ion is selectively hydrolyzed at the malignant lesion. Malignant lesions deficient in the detoxification enzyme but rich in hydrolyzing enzyme, faces death due to this pathway. The normal tissues carrying equal concentrations of both beta-glucosidase and rhodanase are completely protected from the effect of cyanide.

Summary

The anticancer effects of manioc or bitter Apricot seeds are not substantiated with proper scientific research protocols. Nevertheless, many cultures around the globe are freely using them to treat cancers ranging from breast to colon cancers. The results are undefined.

Currently, a retired Sri Lankan ENT specialist along with an oncologist from Phillipines promoted manioc as a effective cancer treatment therapy and when asked about the lack of evidence from clinical studies she says, " no scientific studies were done to evaluate the effects of manioc as a cancer treatment, but those who dared to continue with the treatment had very good results". In supporting the positive anti-tumor claims, some places in Africa and South America where manioc is the staple food there are very few or no known cases of cancer.

Proponents of natural therapy for cancer treatment assert that there is a conspiracy between US-FDA, multinational mega pharma industry and medical community along with cancer society to exploit cancer patients. Because patients suffering from cancer have to incur huge costs for their therapy, but it brings an enormous income to the medical community.

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"If you listen to your body and your intuition, they'll guide you well. There are countless ways to develop listening skills. Some helpful and classic practices include: dancing and drumming, sitting and walking meditations, t'ai chi or chi kung, painting or journal writing. It's important to find what works for you, and even the time of day or night that works best for you. Whatever you choose, the commonality is that they all offer an opportunity for quieting the mind and slowing down enough to be present and able to listen for inner guidance - and guidance from the plants themselves."

- Robin Rose Bennett, The Gift of Healing Herbs: Plant Medicines and Home Remedies for a Vibrantly Healthy Life

COMPARISION OF THE VOLATILE CONSTITUENTS OF THE ESSENTIAL OILS AND ABSOLUTES OF TWO *NYMPHAEA* SPECIES FROM SRI LANKA

*By Yasara H.Wickramasinghe and Lakshmi Arambewela **

Introduction

Nymphaea nouchali is commonly known as "Manel" in Sinhalese and "Water Lilies" in English. Water lilies are represented by the genus *Nymphaea* L. The two species of them are *Nymphaea nouchali* Burm f. and *Nymphaea pubescens* willd which are known as "Manel" and "Olu" respectively in Sinhalese. In the past *Nymphaea nouchali* was known as *Nymphaea stellata*. These colorful flowers of this plant are used in temples as offerings for the Lord Buddha. In addition to their ornamental value, they are also well known to have medicinal properties. *Nymphaea nouchali* is an aquatic flowering plant native to Sri Lanka.[2] *Nymphaea nouchali* Burm f. was declared as the national flower of Sri Lanka on the 26th of February, 1986. Although the national flower was declared as 'Manel' in 1986, no picture was associated with it at that time. This led to the use of the wrong flower to depict the national flower. Till recent times many literature erroneously referred to an exotic violet flowered *Nymphaea* as the *Nymphaea nouchali*.[2] The picture used to depict the national flower was wrong, while its scientific name was correct.[3] This was discovered by Prof. Deepthi Yakandawala back in 2010.[2] The national flower of Sri Lanka is "Manel" and not "Nil Manel".[3] On the 16th of March 2016, the national flower was officially announced as the 'Manel flower' (Sky Blue Manel); where until now the violet flowered *Nymphaea* was recognized as the national flower.[5] Sky Blue Manel grows in smaller, shallow natural water bodies or pools in the dry zone. It mainly grows in areas like Anuradhapura and Polonnaruwa. This flower is hard to locate since it is less abundant.

This violet flowered *Nymphaea* (Nil Manel) is an introduced species which has got naturalized in the local water bodies.[7] This violet flowered *Nymphaea* is a silent invader, Studies have revealed two hybrid populations of *Nymphaea* with intermediate characters, indicating hybridization of the native *N. nouchali* with the exotic violet flowered *Nymphaea*.[2] Sri Lanka's native flower 'Manel' is under the threat of extinction due to the hybridization of invasive alien species with the native flora.[8] Normally

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hybridization occurs when one or more species of the *Nymphaea* are present in the same water body. Hybridization increases the probability or the rapidity of extinction for either one or both species of *Nymphaea*.[7]

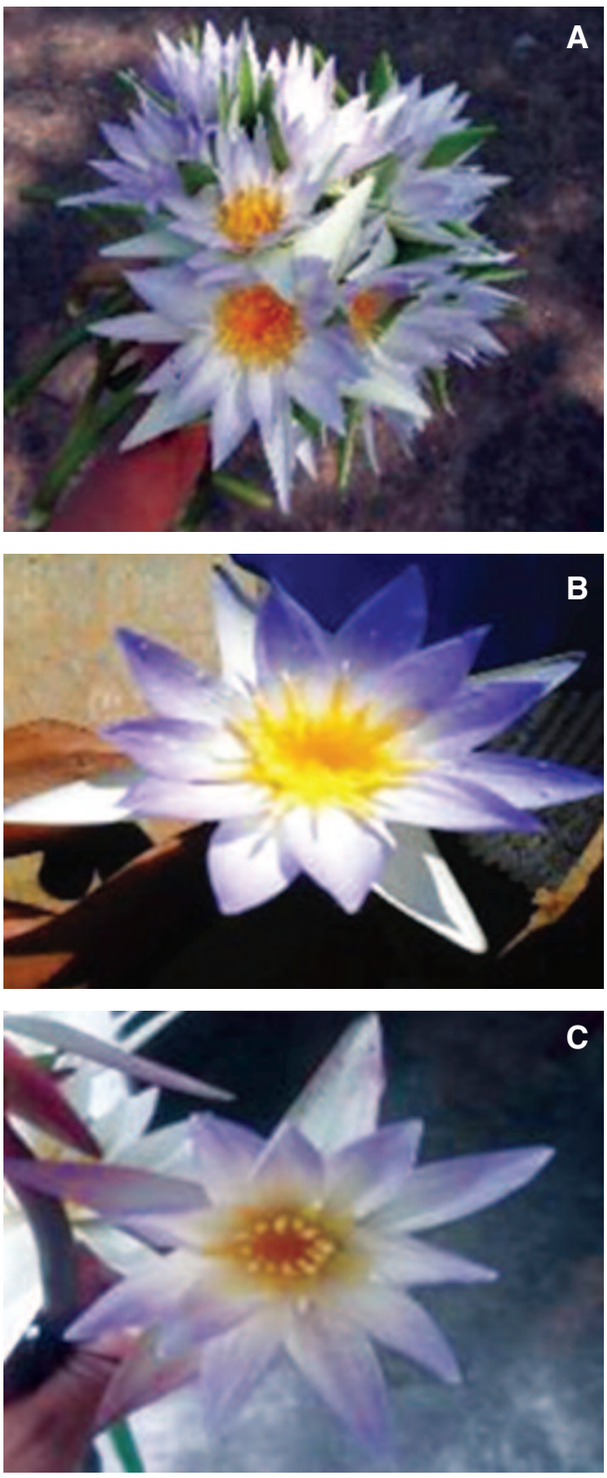


Figure 1:
a - Sky Blue Manel flowers from Anuradhapura (Area 1),
b - Sky Blue Manel flowers from Anuradhapura (Area 2),
c - Sky Blue Manel flowers from Pillawa.

Taxonomy of *Nymphaea* species in Sri Lanka

Kingdom	: Plantae
Order	: Nymphaeales
Family	: Nymphaeaceae salisb.
Genus	: Nymphaea L.
Species in Sri Lanka:	*N. nouchali* Burm f.[9]
	N. pubescens willd.[10]
	Thel-Olu.[9] (vernacular name)

Thel-Olu

Apart from the two commonly known species in Sri Lanka *Nymphaea nouchali* Burm.f. (Manel) and *Nymphaea pubescens* willd (Olu), another group exists by the vernacular name 'Thel-Olu'. Thel-Olu species are native to Sri Lanka. Studies have revealed 'Thel-Olu' to be a 'Manel' species and not an 'Olu' species.[9] Though 'Thel-Olu' is similar to 'Manel', 'Thel-Olu' has showed some distinct morphological features separating it from 'Manel'. Therefore studies have confirmed the presence of an additional *Nymphaea* species in Sri Lanka.[9] In the present research, chemical studies have been carried out to confirm its identity.

Figure 2: Thel-Olu flowers from Pillawa.

'Thel-Olu' seeds are known to be rich in oil, and rice cooked with these seeds is a treatment for nervous ailments and diabetes, according to some Ayurvedic physicians.[9] These are found in the dry zone and a fewer lower wet zone areas.

Morphological Features of
Sky Blue Manel and Thel-Olu

Table 1: The flowers, the leaf upper surface and the leaf lower surface (down the column) of the Sky Blue Manel (standard), Sky Blue Manel (present research), Thel-Olu (standard) and Thel-Olu (present research). (Cey.J.Sci. (Bio.Sci.) 2011 and 2007)[7,9]

Sky Blue Manel (Standard)	Sky Blue Manel (Present research)	Thel-Olu (Standard)	Thel-Olu (Present research)
			
			
			

Table 2 : Comparison of the morphological features of the Sky Blue Manel and Thel-Olu with that of the standards.)[7, 9]

Morphological Feature	Sky blue Manel (Standard)	Sky Blue Manel (present research)	Thel – olu (Standard)	Thel – olu (present research)
Flower color	Pale violet or pale blue fading to a dull blue and yellowish at base.	Pale blue / sky blue and faint yellow at base	White – light blue and yellowish a at base	White and yellow at base
Flower opening time	Open from sunrise to early afternoon	Open from sunrise to early afternoon	Open from sunrise to early afternoon	Open from sunrise to early afternoon
Appendage in stamen	Present	Present	Present	Present
Petal shape	Lanceolate or narrowly elliptic	Lanceolate	Linear - lanceolate	Linear - lanceolate
Sepal shape	Lanceolate	Lanceolate	Linear - lanceolate	Linear - lanceolate
Number of sepals	Four	Four	Four	Four
Petal apex	Acute or sub-obtuse	Acute or sub-obtuse	Acuminate	Acuminate
Number of petals	10 – 15	10 – 15	16 - 20	15 – 20
Number of stamens	12 – 50	20 – 45	20 - 50	25 – 50
Leaf upper surface colour	Green with occasional brown blotches	Green with occasional brown blotches	Not glossy and light green	Not glossy and dark green
Leaf lower surface colour	Dark to light purplish green	Dark to light purplish green	Uniformly purple in colour	Uniformly purple in colour
Leaf lower surface veins	Veins green prominent	Green and purple veins	Purple veins	Purple veins
Leaf texture	Coriaceous.	Leathery or Coriaceous	Less leathery	Less leathery
Leaf lower surface	Glabrous	Glabrous (smooth; no hairs)	Glabrous (smooth; no hairs)	Glabrous (smooth; no hairs)
Petiole colour	Purplish green	Dark – green	Dark – green – brown	Dark – green – brown

Ecology and Distribution of *Nymphaea* Species

Sri Lanka harbours over 3,770 flowering plant species of which over a quarter are considered to be endemic to the island.[7] Sri Lanka is considered as one of the most biologically diverse areas in South Asia. Sky Blue Manel usually grows well in the dry zone and Thel-Olu usually grows in the dry zone and lower wet zone areas.

History of *Nymphaea* Species

Water lilies have been popular as an ornamental aquatic plant since ancient times, as they produce striking flowers throughout the year.[7] An early depiction of 'Manel' flowers is found among the Sigiriya frescoes during the 5th century. 'Manel' flowers have been painted on the hairdo of some 'Apsaras' and on floral salvers held by them.[3]

Traditional uses of *Nymphaea* Species

Nymphaea species are particularly used in the Ayurveda & Siddha systems. *N. nouchali* is used as an ingredient in many polyherbal formulations used for anti-aging, rejuvenation and menstrual irregularities.[11] The rhizome, fruit, leaf, petiole, roots, flowers, tubers and seeds are used as edible parts, in different ways by people.[11] Rhizomes are full of starch and known to be tasty when boiled. Rhizomes are eaten roasted. Tender leaves and flower peduncles are used as curries in Sri Lanka. *Nymphaea* flowers are used as offerings for the Lord Buddha in temples because of the unique beauty and purity. Due to the unique beauty of the *Nymphaea* flowers, they are used as an ornament in different occasions and events for decoration purposes. Due to the sweet fragrance of *Nymphaea* flowers they are used in the perfume industry and also the flowers are used to get the essential oils to be used in the cosmetic industry.

Medicinal uses of *Nymphaea nouchali*

Whole plant : Leaves, roots and flowers together are used for diabetes, blood disorders, antifertility, heart troubles, dysentery, eruptive fevers, indigestion and also as a narcotic, stimulant and as a diuretic.

Flowers :

The flowers are used to treat diabetes mellitus and liver disorders in Ayurveda and Siddha medicinal systems. Flowers are also used for worm infections and burnings of the skin. The decoction of the flower is used in palpitations of the heart and also as a narcotic.[11] The syrup of the flower is used in cases of high fever, and inflammatory diseases of the brain. The filaments of the plants are used as an astringent and a cooling agent in the burning sensation of the body.

Roots :

The roots are used as an emollient, diuretic and to treat diabetes and infections of the urinary passage and also for infertility.[11]

Rhizomes and flowers:

These are used for kidney problems.

Leaf : Used as a lotion in eruptive fevers.

Seed :

Seeds are used as a diet for diabetes mellitus in the Ayurvedic medicinal system.

Rhizome :

Paste from the rhizome is used in the treatment of menstruation problems and rhizomes are used to treat gastrointestinal disorders.

Petiole :

Petiole along with some other ingredients are taken against excessive menstrual discharge and also bleeding during pregnancy.[11]

Chemistry and Pharmacological properties of *Nymphaea nouchali*

Different solvent extracts of the entire plant have shown the presence of saponins, tannins, sterols, alkaloids and flavonoids.[11] Nymphayol; which is a new sterol has been

isolated from the chloroform extract of the flower. In the seeds; pentosan, mucilage, proteins and tannins are found.[11] Corilagin, gallic acid, astragalin, gallic acid, methyl ester, isokaempferide, kaempferol, quercetin-3-methyl ether, quercetin, dextroglucose, dextro xylopyranoside have been identified in the flowers.[11] Phytochemical analysis of methanolic extracts of stems have yielded flavonoids, alkaloids, saponins and tannins.[13] Studies have shown antioxidant, antinociceptive, antimicrobial, antidiabetic, cholinergic, antihepatotoxic and anti-inflammatory properties. Studies have revealed antibacterial activity of *Nymphaea nouchali* flowers on human and plant pathogenic bacteria.[14] Studies have revealed antihyperglycemic activity of a hydro alcoholic extract of *Nymphaea nouchali* seeds.[15] The results have shown significant restoration of blood glucose to normal levels showing antidiabetic properties.[15] The alcoholic extracts of *Nymphaea nouchali* flowers have shown hepatoprotective activity.[13]

Objective of the Present Study

As several types of *Nymphaea* flowers have been identified in Sri Lanka, it is important to analyse the chemical constituents to inter-relate these types by their chemical composition. The present study conducts chemical studies on essential oils and absolutes of the native sky-blue *Nymphaea nouchali* flowers (Manel) and the *Nymphaea* species known as 'Thel-Olu' using GC and GC-MS analysis.

Flowers for Analysis

Figure 8 : Thel-Olu

Sky Blue Manel

Fresh 'Thel-Olu' flowers were purchased from Pillawa. Sky Blue Manel flowers were collected from a natural wet land from Anuradhapura. The petals were removed and collected while the middle part of the flower containing the stamens were cut into small pieces. The weights of the flowers without the petioles were obtained before the extraction.

Preparation of the Concretes of the *Nymphaea* species

The flowers were weighed and cut in to small pieces. (weight of the Thel-Olu flowers was 1850.0 g and weight of the Sky-blue Manel flowers was 2200.0 g). Then they were soaked in hexane and kept on the shaker overnight. It was fixed at 45 rpm. Then the hexane extract was obtained by filtering was evaporated using the rotary evaporator. The material thus obtained was the concrete.

Preparation of the Absolutes of the *Nymphaea* Species

To the concrete distilled 96% ethanol was added and extracted through solvent extraction. The ethanolic extract was kept in the deep freezer overnight.[16] After the waxes separated, the solvent was filtered, ethanol was evaporated using the rotary evaporator and the absolutes were obtained.[16]

TLC of the Absolutes

Solvent System Toluene: ethyl acetate (7:3)
Spray Reagent Vanillin sulphate (0.5 g) was dissolved in conc. Sulphuric acid (80ml) and 96% ethanol (20ml) and the spray reagent was obtained. This was stored in a plastic spray bottle.

Procedure 12.00 mg of the Sky Blue Manel absolute and 12.00 mg of the Thel-Olu absolute were dissolved in 0.5 ml of methanol respectively. The TLC plate was spotted with the 2 absolutes. After spotting the TLC plate they were developed using the solvent system toluene: ethyl acetate (7:3). Developed plates were dried on a heater and were observed under the UV light. Plates were sprayed with vanillin the sulphate spray reagent for the visibility of the spots. Another set of plates were visualized using an iodine bath to observe the visibility of the unsaturated components.

Analysis of the Absolutes using GC-FID

Instrument :

Thermo Scientific™ TRACE™ 1300 Gas Chromatograph with FID detector, TG – WAXMS GC column, (30 × 0.25 × 0.25), Maximum temperature – 250/260 ˚

Oven Programming Maximum temperature: 250.0 ˚C Initial temperature : 50.0 ˚C Initial hold time: 1.00 min Ramp 01 rate: 4.0 ˚C/min Ramp 01 final temperature : 210C Ramp 01 hold time: 30.00 min

Detection : FID – Front method Flame on: Temp: 260 ˚C

Analysis of the Essential Oils using GC-MS Instrument

Thermo Scientific™ TRACE™ 1300 Gas Chromatograph, TG – WAXMS GC column, 30 × 0.25 × 0.25), Maximum temperature – 250/260 ˚C

Sampling Sample volume : 1.00 µl MS transfer line temperature: 250 ˚C Ion source temperature: 250 ˚C Ionization mode: EI

Oven Programming Maximum temperature : 250.0 ˚C Initial temperature: 50.0 ˚C
Initial hold time : 1.00 min Ramp 01 rate: 4.0 ˚C/min

PTV - Front method PTV mode : CT split Split flow: 5.0 ml/min Purge flow: 5.0 ml/min Carrier mode: Constant flow Carrier flow: 1.000 ml/min

Table 4 : % Yields of the essential oils

Flower species	Weight of the flowers/g	Weigh of the essential oil/g	% Yield of the essential oil
Thel-Olu	3,888.51	0.4985	0.0128
Sky Blue Manel	1,949.45	0.5210	0.0267

Table 5 : % Yields of the absolutes

Flower species	Weight of the flowers/g	Weigh of the essential oil/g	% Yield of the essential oil
Thel-Olu	1,850	1.7863	0.0965
Sky Blue Manel	2,200	0.7390	0.0336

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

- Chuck Palahniuk, Choke

Thin Layer Chromatography

Visibility of the Spots of the Absolutes under the UV Light

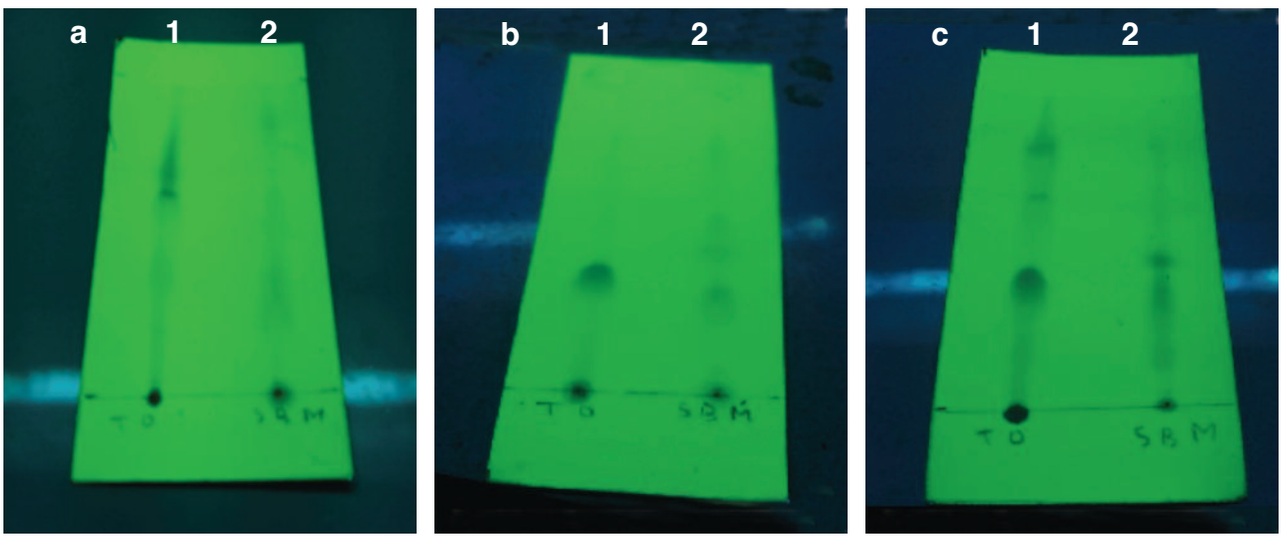
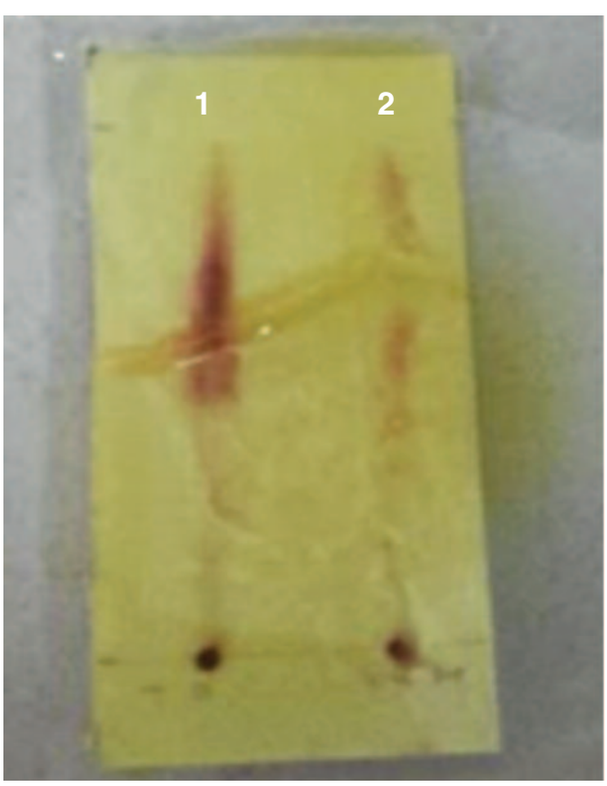


Figure 12: a - TLC run 1, b - TLC run 2, c - TLC run
Spot 1 – Thel-Olu absolute, Spot 2 – Sky Blue manel absolute

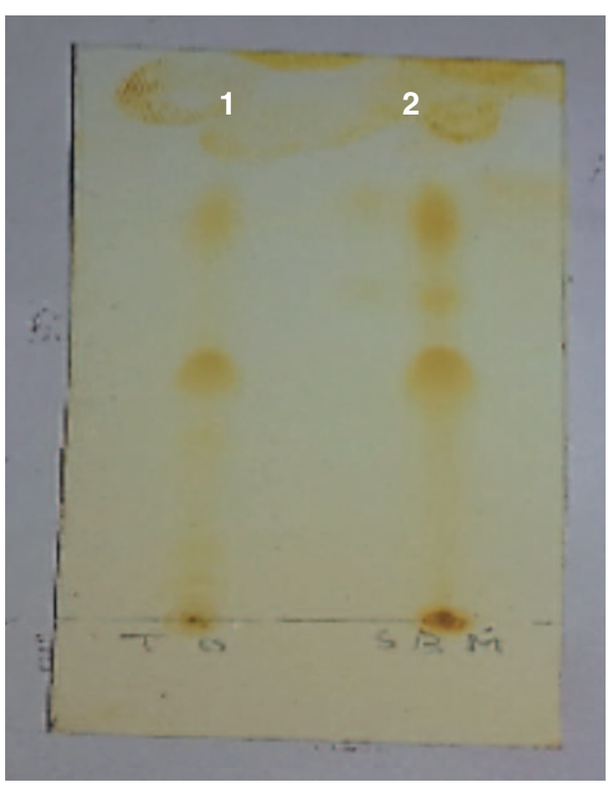
Visibility of the Spots of the Absolutes after Spraying the Spray Reagent



Spot 1 - Thel-Olu absolute

Spot 2 - Sky Blue Manel absolute

Visibility of the Spots of the Absolutes after Keeping in the Iodine Bath



Spot 1 - Thel-Olu absolute

Spot 2 - Sky Blue Manel absolute

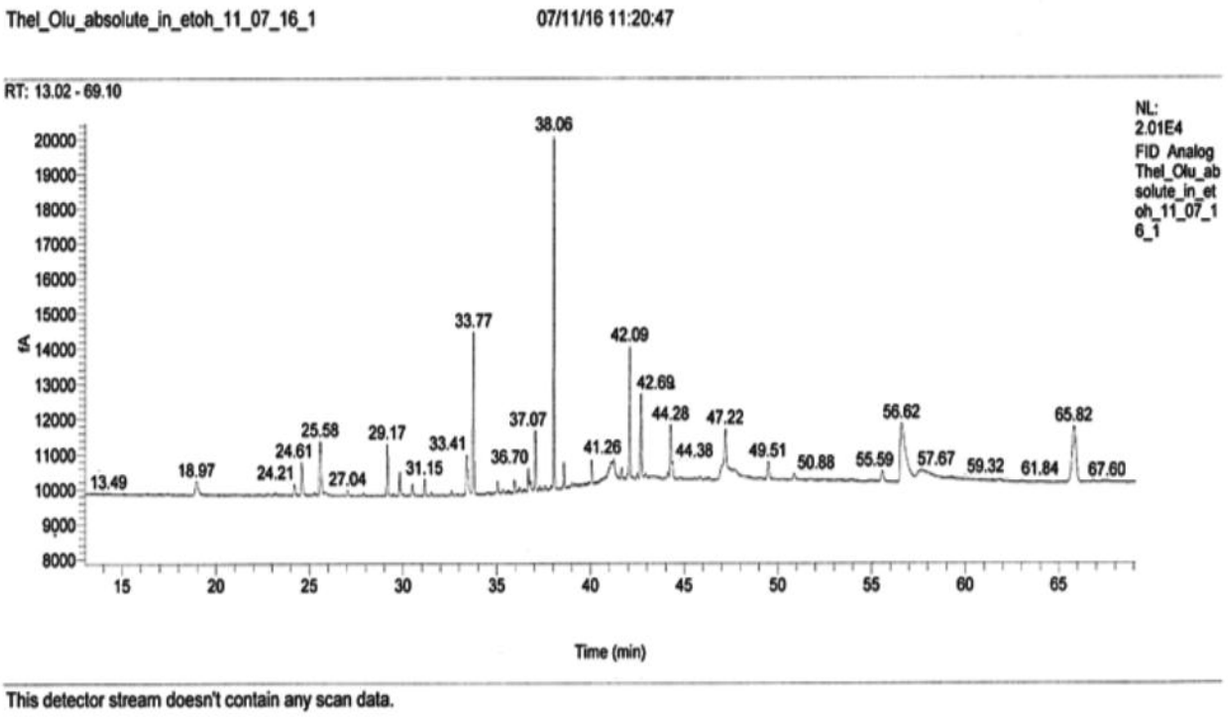
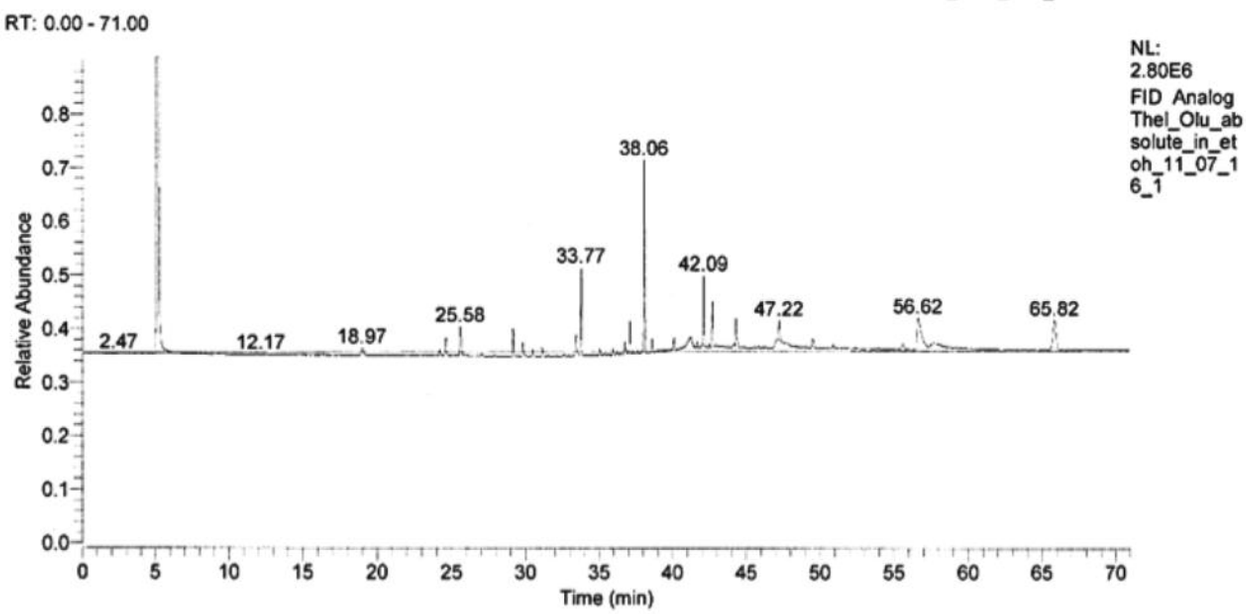


Figure 15 : GC of the Thel-Olu absolute in ethanol

GC-FID Results for the Thel-Olu Absolute

Data File: Thel_Olu_absolute_in_etoh_11_07_16_1
Original Data Path: C:\Essential Oil\Users\HW\Customer samples\Ichem_Dr Arabawela\Results_16_07_11
Acquisition Date: 07/11/16 11:20:47 AM
Run Time(min): 71.02
Instrument Method: C:\Essential Oil\Users\HW\Customer samples\Ichem_Dr Arabawela\Method\HW-Essential Oil_PTV_FID_Yasara.meth



Qual Peak Table			
RT	**Peak Area**	**Area %**	**Peak Height**
18.97	2,697.35	1.66	320.81
24.60	4,357.18	2.68	904.92
25.58	8,116.90	4.99	1,483.63
29.17	5,513.36	3.39	1,454.52
29.83	2,817.55	1.73	646.92
33.41	6,729.71	4.14	1076.55
33.77	16,049.37	9.87	4556.09
36.07	2271.70	1.40	635.79
37.08	6,159.88	3.79	1,691.38
38.06	34,740.64	21.36	10,047.35
38.60	2,472.85	1.52	716.08
41.26	2,782.18	1.71	463.77
42.09	13,235.46	8.14	3,708.22
42.69	9,496.88	5.84	2,365.33
44.28	6,690.97	4.11	1,453.92
47.22	7,347.54	4.52	1,163.13
49.51	2,903.89	1.79	461.13
56.61	13,502.73	8.30	1,269.92
65.82	7,458.08	4.59	1,269.92
65.85	7,270.76	4.47	1,256.68

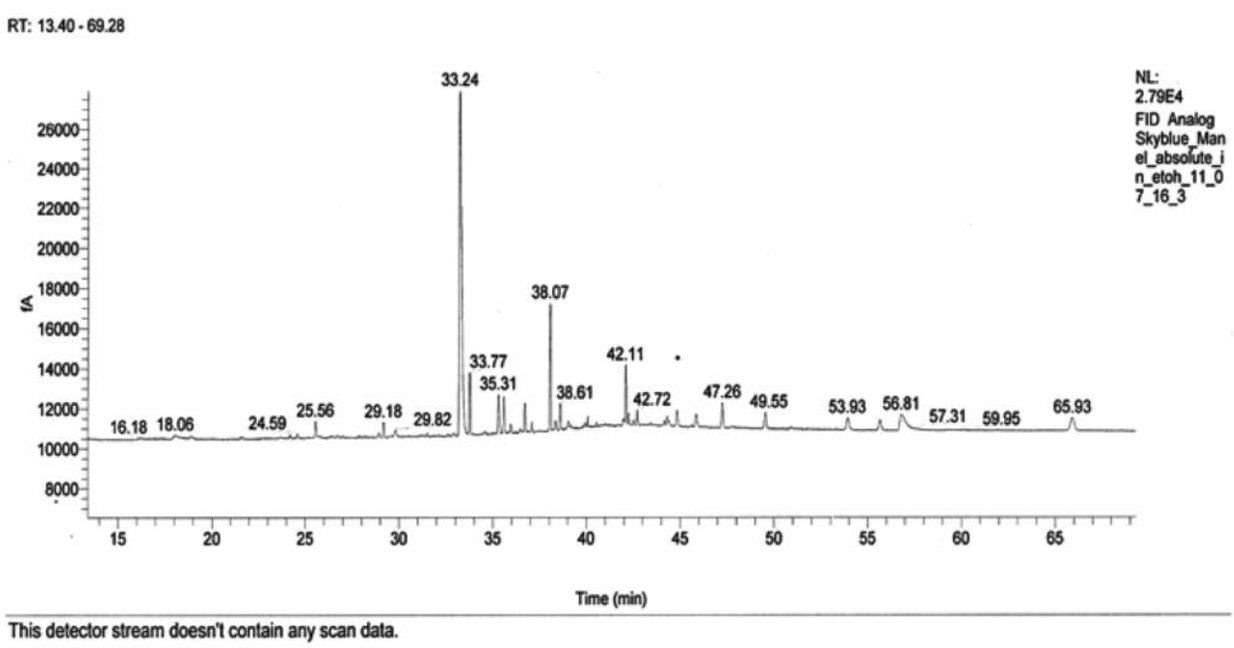


Figure 16: The GC of the Sky Blue Manel absolute in ethanol

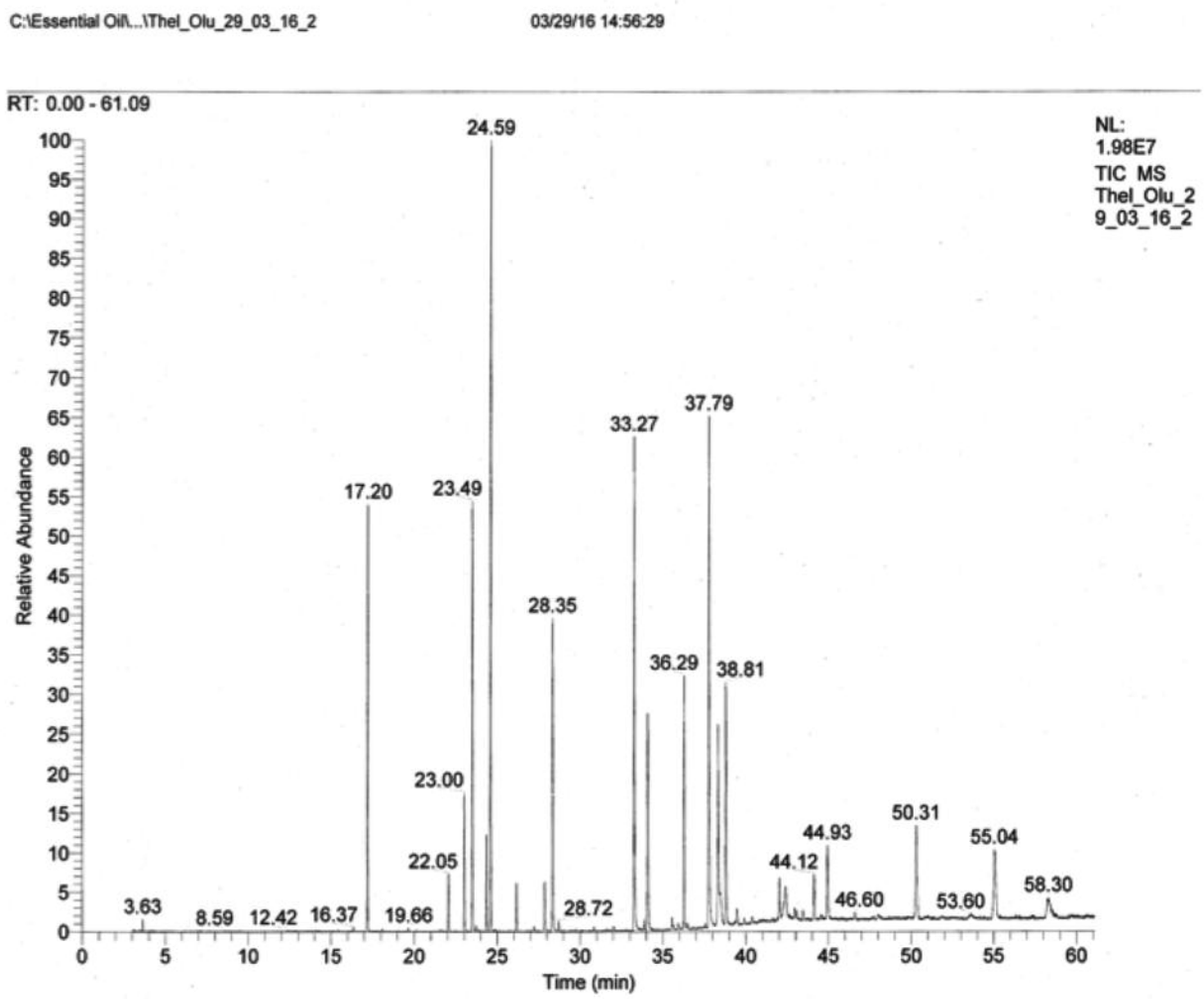


Figure 17: GC of the Thel-Olu essential oil

Table 6: GC-MS Results for the Thel-Olu Essential Oil

Retention Time/Min.	Area%	Compound
17.20	7.28	Pentadecane
23.00	2.53	Hexadecane
23.49	8.69	1-Hexadecanol
24.34	1.89	α-Farnesene
24.59	**16.90**	**cis-7-Dodecen-1-ol**
27.87	1.32	Benzyl alcohol
28.35	6.17	Eicosane
33.27	10.24	Heneicosane
34.09	5.71	Dodecanal
36.29	5.48	2-Nonadecanone
38.35	6.18	n-Heptadecanol-1

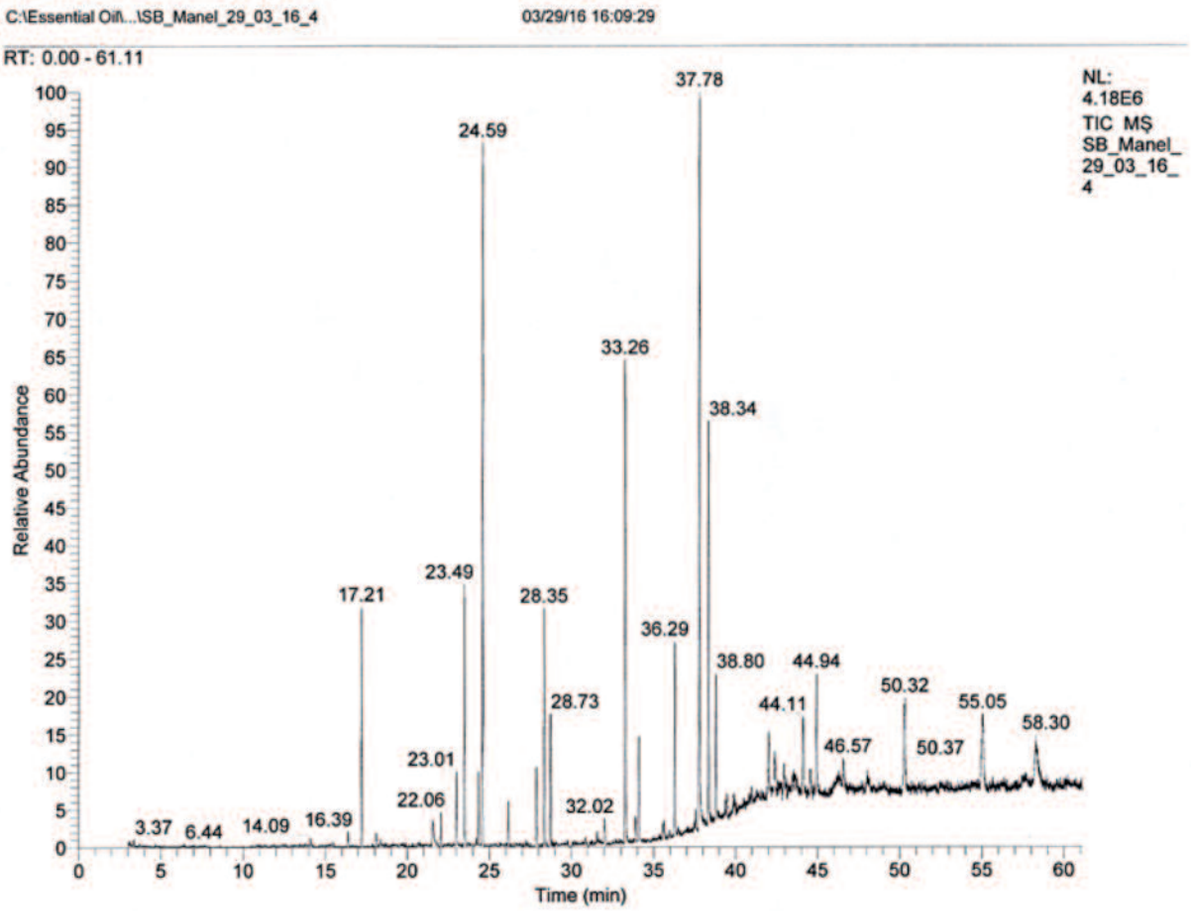


Figure 18: GC-MS of the Sky Blue Manel essential oil

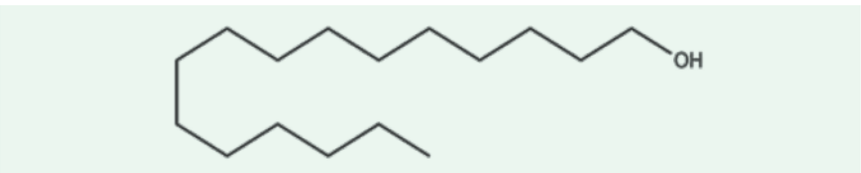
Retention Time/Min.	Area%	Compound
17.21	13.44	Pentadecane
21.56	0.58	Benzeneacetaldehyde
23.00	1.38	Dodecane,2,6,10-trimethyl-
23.49	5.37	1-Hexadecanol
24.35	1.35	α-Farnesene
24.59	15.35	cis-7-Dodecen-1-ol
27.88	1.95	Benzyl alcohol
28.35	4.70	Tridecane
33.26	11.07	Hexadecane
34.09	2.61	Dodecanal
36.29	4.40	2-Nonadecanone
37.78	18.10	Tridecane,2-methyl-
38.34	9.65	2-Pentadecanol
38.80	3.62	Undecanal

Table 7: GC-MS Results for the Sky Blue Manel Essential Oil

Structures of the Major Compounds

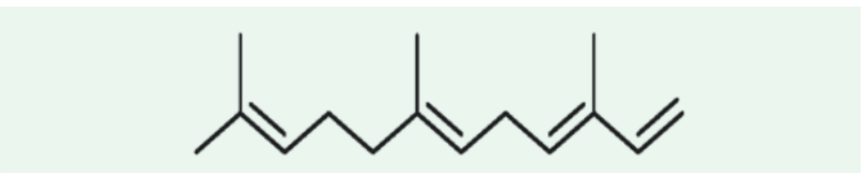
cis-7-Dodecen-1-ol

$C_{12}H_{24}O$



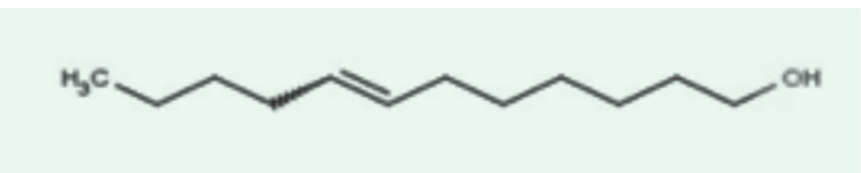
1-Hexadecanol

$C_{16}H_{34}O$



à-Farnesene

$C_{15}H_{24}$



Tridecane,2-methyl-

$C_{14}H_{30}$

Discussion

According to the Thin Layer Chromatographic studies, the spots visualized for the two Manel species, 'Thel-Olu' and 'Sky Blue Manel' showed somewhat similar retention values, when visualized under the UV light but the concentrations were different. When the spots were visualized using the iodine bath, unsaturated compounds present were visualized. Thel-Olu had two spots while Sky Blue Manel had three spots. The common spots of the two Manel species showed somewhat similar retention values. From the TLC analysis it appears that Sky Blue Manel and Thel-Olu have some common compounds.

According to the GC results of the two absolutes of the Thel-Olu and Sky Blue Manel; both shows some similar peaks with slight differences in the concentrations. According to the GC-MS results of the two essential oils of the Thel-Olu and Sky Blue Manel; both essential oils too showed some similar peaks with slight differences. In Thel-Olu essential oil chromatograph the highest peak had a retention time of 24.59 min, which was identified as cis-7-Dodecene-1-ol. In the Sky Blue Manel the highest peak had a retention time of 37.78 min, and the compound was identified by the GC-MS data as Tridecane 2-methyl. Pentadecane, cis-7-Dodecen-1-ol, 1-Hexadecanol, α-Farnesene, Benzyl alcohol, Hexadecane, Dodecanal and 2-Nonadecanone are the common compounds which are present in both the species. According to the GC-MS results obtained, Benzene acetaldehyde, Dodecane,2,6,10-trimethyl-, Tridecane, 2-methyl-, 2-Pentadecanol and Undecanal compounds are present only in the Sky Blue Manel. The GC-MS results indicated that Eicosane, Heneicosane, n-Heptadecanol-1, 9-Octadecen-1-ol,(Z) compounds are present only in Thel-Olu.

The major morphological differences in these two species were seen in the flower colors, petal numbers, stamen numbers, the leaf upper surface and the leaf lower surface. Even though there are morphological differences, the GCs of the absolutes and the GC-MSs of the essential oils are somewhat similar. When considering the GC-MS data of the violet flowered Nymphaea species, from the research work carried out in 2014, the major peak in the essential oil of flowers

was identified as 6,9-heptadecadine. When comparing the GC-MS data of the violet flowered *Nymphaea* of the previous studies with the Thel-Olu and Sky Blue Manel, the violet flowered Nymphaea shows differences in volatile constituents, from that of the two Manel species of the current study.

Conclusion This study revealed that flowers of Sky Blue Manel and Thel-Olu have more common volatile constituents than Sky Blue Manel and violet flowered *Nymphaea* (Nil Manel).

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True worth is in being – not in seeming

In doing , each day that goes by,

Some little good – not in dreaming

Of the great things to do by and by

Alice Cerg 182- -1871

TORBJORN NORIN - A SCANDINAVIAN CHEMIST WITH A VERSATILE RANGE OF INTERESTS

By R.O.B. Wijesekera

Torbjorn Norin is one of the best known chemists from Sweden and renowned for the versatile range of his research interests and active participation in each of them. Unfortunately his sudden demise during the recent pandemic spell of COVID 19 cut his life off at the height of his activities. His untimely death left a void in the versatile researches he pursued as well as in the multiple institutions he was serving both in Scandinavia and globally. He will be greatly missed by the research community he worked with and who placed much dependence on his experience and knowledge.

Professor Norin graduated with a grounding in engineering before switching on to organic chemistry which was his main research area for many years. He was interested in both synthetic chemistry as well as organic chemistry, particularly in bioactive agents from plants. This was the main interest that took the author on a lecture tour in 1960 to Stockholm when he first met Norin. Norin was then a young man mentor to a young colleague of his, Donald Wijekoon, who too has now joined the ranks of the deceased, but was then in Stockholm at the same time. It was later that Norin was to reach the greater heights of fame, when he became a distinguished global actor in the international chemical scenario.

In his time Professor Norin was to be the recipient of several International awards notably the following:

The Norblad-Ekstrands Medal of the Swedish Chemical Society; The Oscar Carlsen Medal, and in addition he was a Fellow of The Royal Swedish Academy of Sciences, Fellow of Academy Europoea, and a Foreign member of the Royal Norwegian Sciences and Letters.

A popular colleague among fellow scientists he was a welcome figure among the global scientific community and will be sadly missed in the years to come.

LINK NATURAL PLAYS A KEY ROLE IN COMBATING COVID 19 IN ITS WORK ENVIRONMENT

By Chandima Premaratne

COVID 19, the virus infection which began in December 2019 in Wuhan, China has been declared a pandemic by the World Health Organization. This has caused a significant damage to the world population and the global economy.

The fallout of COVID 19 has exacerbated the already fallen economy in Sri Lanka which took a beating with the Easter Sunday attacks of April 2019. It is thus the second such external shock which hit the country within the last year. The ripples of the destructive element had not been fully dissipated by the time the effects of the COVID 19 hit the country. It completely crippled the economy inflicting a heavy cut in exports and disrupting the activities of the agricultural, industrial and service sectors.

The Government of Sri Lanka introduced various sequential measures to prevent the spread of the virus such as social distancing, disinfection, closure of workplaces, imposing travel bans to international arrivals and drastically an Islandwide curfew was introduced.

Link Natural has taken all the necessary steps recommended by the Health Ministry to prevent the spread of the virus in the workplace by adhering to strict precautionary measures. Protecting the workforce and redeploying their unique capabilities to meet society's immediate needs has been the primary responsibility of Link Natural. The production commenced on a limited scale on 10th March 2020 adhering to all rules and guidelines imposed by the Sri Lankan Government on proper hygiene methods. The management reviewed the policies and practices such as limiting operations to essential processes with flexible working hours and office arrangements to maintain the required physical distances at the factory. Further, arrangements were made to introduce alternate days and extra shifts to reduce the total number of employees at the workplace at any given time. At this hour of need the Company maintained the strict Governance procedures to ensure the products manufactured and distributed throughout the country adhered to the highest standard of quality and efficacy.

Procedures Set up

A distinguished medical team was appointed to educate employees about the COVID 19 virus and the precautionary measures that need to be taken while a dedicated team within the Company was set up to ensure the internal and external safety of all employees and visitors entering the premises. The necessary educational materials were also displayed in the premises for the use of the employees. Important

information about the pandemic situation and related behavioural instructions were displayed at key areas mainly using picture advertisements.

Precautionary Measures

- Washing of hands – The Company uses foot operated taps for this purpose. Hand sanitizers are used after using the fingerprint scanner.

- Masks and gloves were provided to all employees. They were strictly advised to refrain from touching the masks they were wearing and avoid touching the faces.

- Thermometers are used at the entrances to monitor the body temperatures and identify the employees with temperatures above 37 ^{0}C.

- Oximeter - The Oximeter is used to detect the level of oxygen of the employees and those showing less than 95% were considered to be having a low oxygen level and directed to a medical officer.

- Disinfection of footwear- Rubber carpets are disinfected using 0.1% Sodium Hypochlorite in a plastic tray.

- Disinfectant Spray machine-The spray machine is used to disinfect vehicles, floors and walking paths using 0.1 % Sodium hypochlorite before starting work in the morning and midday.

- Automatic hand disinfectant- An automatic sensor specially designed for disinfecting the hands is used.

- Paddle operated taps-Non-contact taps were placed at several locations (Main entrance, cafeteria, washrooms and R&D Park) to make sure all the employees washed their hands at each instance.

- Face Shield and overall-All the employees exposed to contact at the front end were instructed to wear the face shield in order to minimise contact.

- Fumigation-All supply, transport and delivery vehicles are fumigated and sanitized at the main entrance using disinfectants.

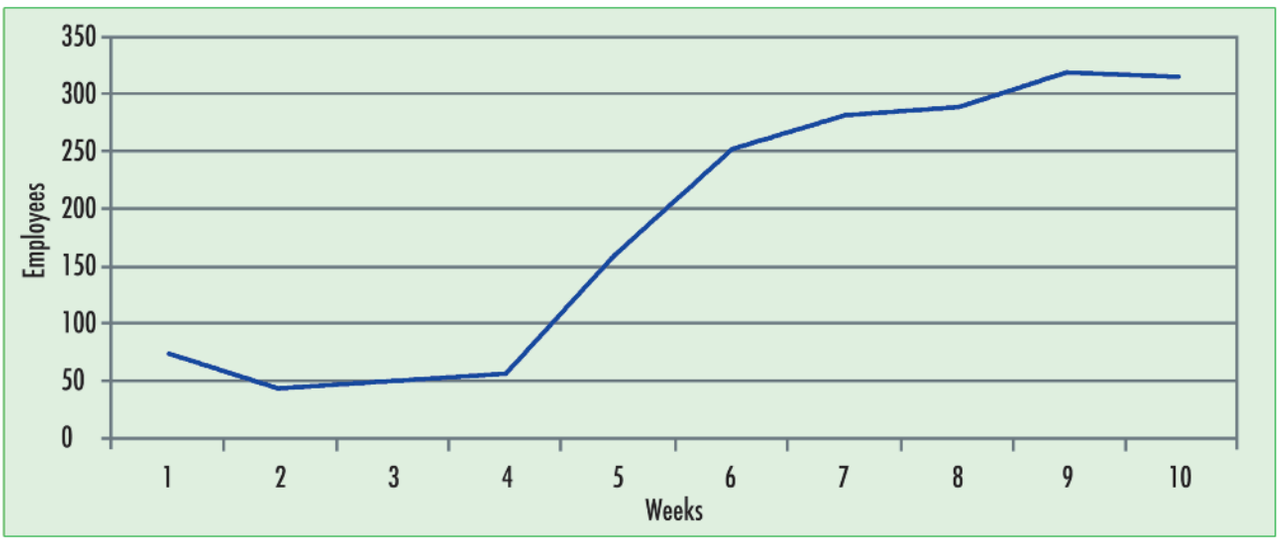
Average attendance of company employees during this period (Weekly Average)

Month	**March**			
Week	week 1	week 2	week 3	week 4
Day Average	-	-	73	44

Month	**April**			
Week	week 1	week 2	week 3	week 4
Day Average	53	55	161	249

Month	**May**			
Week	week 1	week 2	week 3	week 4
Day Average	281	290	318	315

The following graphical presentation shows the attendance of the Employees during this period.



Traditional Knowledge

Victorian explorers called them "lost tribes" contemporary scientists call them " indigenous peoples" …

Expelled from the planet by civilization sprawl, they will take with them knowledge we are only beginning to appreciate. Stored in the memories of elders, healers, mid wives, famers, fishermen and hunters in the estimated 25,000 such cultures remaining on earth is an enormous trove of wisdom.

Over the ages, indigenous peoples have developed innumerable technologies and arts, they have devised ways to farm deserts without irrigation; they have learned how to navigate vast distances in the Pacifica using their knowledge of currents and the feel of intermittent waves that bounce off distant islands; they profit from the medicinal properties of little known plants. Much of this expertise and wisdom has already disappeared and if neglected, most of the remainder could be gone within the next generation …

The most intractable aspect of the crisis is largely voluntary. Entranced by images of wealth and power of the First world the young are turning away from their elders and their ways, breaking an ancient but fragile chain of oral tradition.

"Great Discoveries Time 2001"

Who is in or out, who moves the grand machine
Nor stirs my curiosity or space;
Secrets of state no more I wish to know
Than secret movements of a puppet show,
Let but the puppets move, I've my desire
Unseen the hand which guides the master wire

Churchill

TREE PLANTING FOR INDEPENDENCE DAY CELEBRATION

By CSR Department

Link Natural Products acts as a socially responsible company, bound to promote social and environmental wellbeing while achieving its business objectives and maintaining ethical business practices. To achieve its social responsibility commitment, it reinvests some part of its profits on social and environmental developments programs. Just as global attention is placed on reaching the sustainable development goals, Link Natural also directs its programs and activities based on the sustainable development approach.

In a bid to contribute towards mitigating adverse environment problems such as climate change and global warming, Link Natural commenced a project under the theme *"Thuru athi thuru* – lighten up the nature by Link Natural", to plant trees throughout the country with the collaboration of the government and non-government institutions and schools. Under this project the company has contributed a large number of plants throughout past few years.

Another initiative of this project was to conduct a tree planting and plant distribution program at the company premises for the employees, parallel to the 72nd Independence Day celebration on 04th February 2020. The significance of this project was that all the trees planted were rare herbal plants that are not easy to find in the environment, and this highlighted the fact that Link Natural Products uses 100% natural ingredients for production. Special herbal plants like "Ankenda (*Acronychia pedunculata*), Beli (*Aegle marmelos*), and Yakulmaran (*Syzygium zeylanicum*) were planted in the company premises and all the employees in the company were given 1000 "Ela batu" plants that are used as one of the main ingredients of Link Natural Enriched Paspanguwa. The bonus accruing to the employees through this programme is that the employees are given the opportunity to sell the grown tree to the company at a fair value.

In addition to its environmental impact, the project also provides motivation to its employees and their families and community to plant more trees, for the benefit of future generations.

Tree Planting Campaign

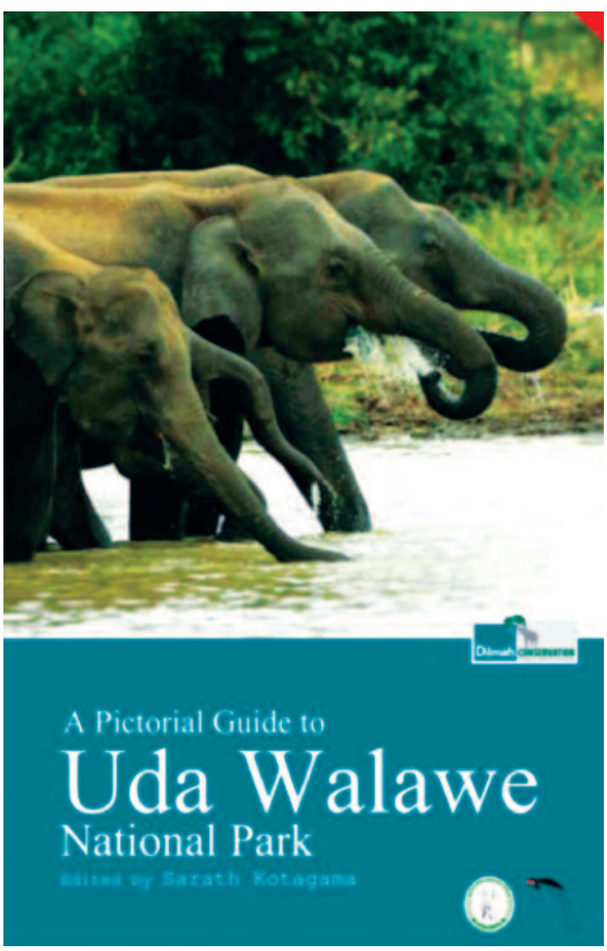
AVAILABILITY OF LINK PRODUCTS

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

A PICTORIAL GUIDE TO UDA WALAWE NATIONAL PARK



Book : ***A Pictorial Guide to Uda Walawe National Park***

Authors : *Sarath Kotagama*

ISBN : *9789558576335*

Publisher : *Field Ornithology Group of Sri Lanka, in collaboration with Dilmah Conservation*

Paperback : *315 pages*

Uda Walawa National Park is an important Protected Area in southern Sri Lanka that is home to a variety of plant and animal species, including not only elephants, leopards and deer that the reserve is famed for, but also rare migratory and endemic birds, and a rich array of insects, reptiles, amphibians and fish. This comprehensive pictorial guide provides an excellent overview of the Park's rich floral and faunal diversity and is geared towards helping both visitors and those interested in additional information on the numerous species found within Uda Walawe National Park.

https://www.nhbs.com/title?slug=a-pictorial-guide-to-uda-walawe-national-park-book

DIGEST MAIL BOX

Letter 1

Pl be kind enough to let me know how to get copies of the Digest.

Gunasekera

Response
Dear Mr. Gunasekera,
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Herbs and Spices

Herbs and Spices are much used ingredients in the cuisines of most countries of the world, used to add flavor and enhance the taste of dishes and sometimes for the purpose of preservation. Some even add colour and nutrients and impart an agreeable aroma. But how many have paused to wonder as to what constitutes a herb and what constitutes a spice? One thing in common is that they both are parts of plants, be it fresh or dried. The difference lies in from which part of the plant they are obtained from. Herbs come from the leafy and green part of the plant, whereas Spices are parts of the plant other than the leafy part such as the root , stem, bulb , bark or seeds.

Examples of herbs include basil, oregano, thyme, rosemary, parsley and mint. These herbs are more predominantly grown in temperate areas and many of them are reputed to have great medicinal value.

Spices thrive in the tropical regions and area usually dried before use in foods. Common examples of spices are cinnamon, clove, ginger, cardamom, nutmeg, cumin and pepper. They are also been known to preserve foods and some have medicinal value, such as turmeric with its anti-inflammatory, anti-fungal properties

However, it is interesting to note that according to the American Spice Trade Association, spices are defined as "any dried plant product used primarily for seasoning purposes". This really broadens the definition of spices, allowing it to include herbs, dehydrated veggies, spice blends and spice seeds.

https://www.fooducate.com/community/post/What-s-the-Difference-Between-Herbs-and-Spices

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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