

Chemical aspects of curry leaves (*Murraya koenigii*)

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Curry leaves (in Sinhalese “Karapincha”) or *Murraya koenigii* is one of the most famous plants in South Asian region not only as a taste enhancer, but also an important medicinal plant. According to Hinduism, curry leaves are referred to as “Surabhinimba” in Sanskrit language, as this plant is blessed by the goddess “Lakshmi” who belongs to wealth and prosperity. In Ayurveda, this plant is used to balance three doshas which are named as Vatta, Pitta and Kapha. However, recently scientists have discovered that curry leaves contain many phytochemicals such as alkaloids, flavonoids, polyphenols, *etc.* which are known to possess medicinal properties namely antidiabetic, antioxidative, anticancer, anti-obesity, antihyperlipidemic, antiulcer, antimicrobial, and anti-fungal, cardio protective and hepatoprotective properties [1-5].

Taxonomy

Kingdom	- Plants
Sub-Kingdom	- Tracheobionta
Super division	- Spermatophyta
Division	- Mangnoliophyta
Class	- Mangnoliospsida
Sub-Class	- Rosidae
Order	- Sapindales
Family	- Rutaceae
Genus	- <i>Murraya</i>
Species	- <i>M. koenigii</i>

Distribution and Morphology

Curry leaf tree is a deciduous plant present in India, Sri Lanka, Bhutan, Laos, Nepal, Pakistan, Thailand, Malaysia, South Africa, *etc.* [6,7]. Other types of curry leaf species found in Sri Lanka are *Clausena indica* (Meegon karapincha/Indian wampi), *Micromelum*

minutum (Limeberry/Wal Karapincha) *etc.*, [8].

Murraya koenigii plant (Figure 1) grows as a shrub or tree having a height up to 6 m and of trunk diameter up to 15-40 cm.



Figure 1: *Murraya koenigii* tree

Pinnately compound leaves (15-30 cm length) contain 11-25 leaflets. Length of each leaflet is around 2-4 cm while, breadth is about 1-2 cm (Figure 2). White colored, funnel-shaped, bisexual, sweetly fragrant flowers are arranged in terminal cyme inflorescence bearing 60-90 flowers (Figure 3). Black color ripe fruits of the curry leaf plant have small greenish colored seeds (Figure 4) [1,2,7-9].



Figure 2: Pinnately compound curry leaves



Figure 3: Inflorescence of curry leaves trees



Figure 4: Ripped fruits of curry leaves plant

Comparing to *Murraya koenigii*, *M. minutum* is a tall tree (approximately 9 m). The pinnate leaves of this species contain 7-15 large leaflets (*i.e.*, each leaflet is 2-10 cm long, 1-6 cm broad). Length of a leaflet of Indian wampi tree is about 3.7-8 cm and the length of a leaf is about 30 cm. According to maturity, fruits of *M. minutum* show yellow, orange, and red color, whilst berries of *Clausena indica* are pink, or cream colored [8].



Figure 5: *Clausena indica* tree



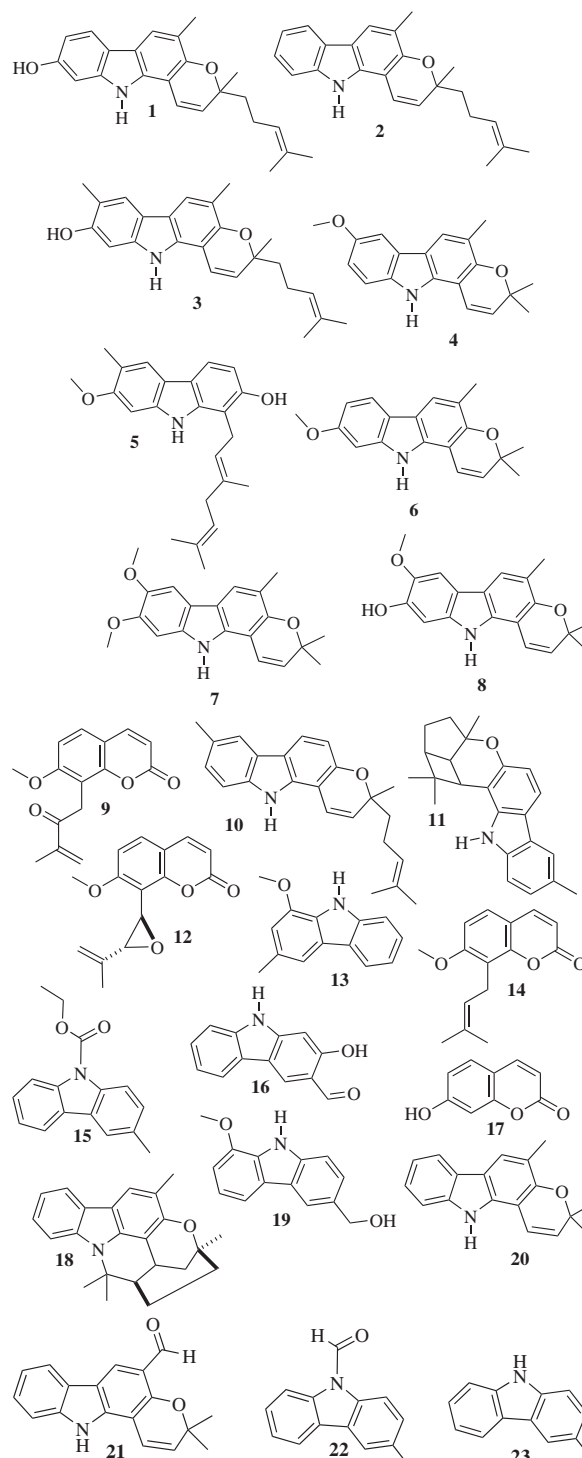
Figure 6: *Micromelum minutum* tree

Phytochemicals in Curry leaves

Phytochemicals are primary or secondary metabolites which provides protection to the plants. Curry leaves contains these bio-active compounds such as alkaloids, flavonoids, terpenoids, essential oils, *etc.* [8-13].

Mahanine 1, mahanimbine 2, isomahanine 3, koenimbine 4, murrayanol 5, O-methylmurrayamine-A

6, koenigicine 7, koenigine 8, murrayone 9, mahanimbicine 10, bicyclomahanimbicine 11, phebalosin 12, murrayafoline A 13, osthol 14, 9-carbomethoxy-3-methyl carbazole 15, mukonal 16, umbelliferone 17, murrayazoline 18, mukoline 19, girinimbine 20, murrayacine 21, 3-methyl-9H-carbazole-9-carbaldehyde 22, 3-methylcarbazole 23, murrayakonine A 24 are some of the alkaloids present in curry leaf plant (Figure 7) [1,2,10-13].



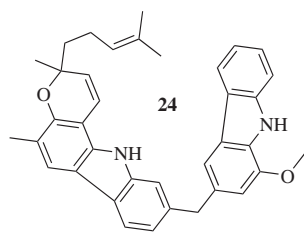


Figure 7: Some alkaloids present in curry leaf plant.

Flavonoids such as quercetin **25**, apigenin **26**, kaempferol **27**, rutin **28**, catechin **29**, myricetin **30**, and terpenoids (Figure 9) such as blumenol A **31**, icariside B1 **32**, loliolide **33**, (+)-sabinene **34**, β -pinene **35**, etc. are also found in curry leaves (Figure 8) [13].

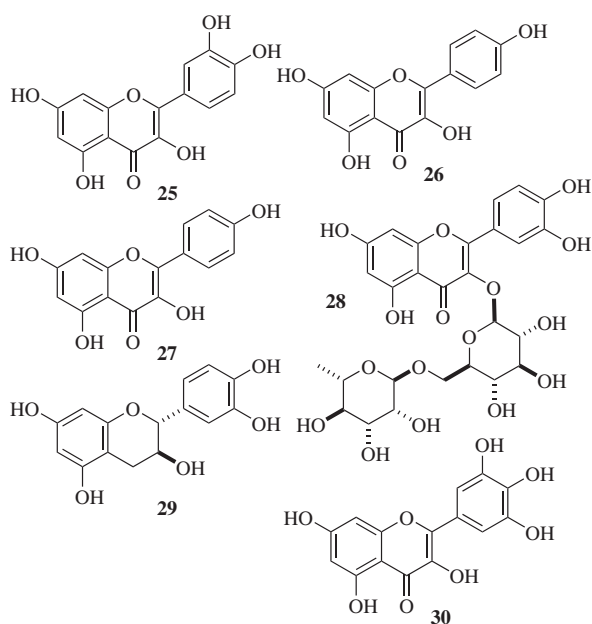


Figure 8: Some flavonoids present in curry leaves

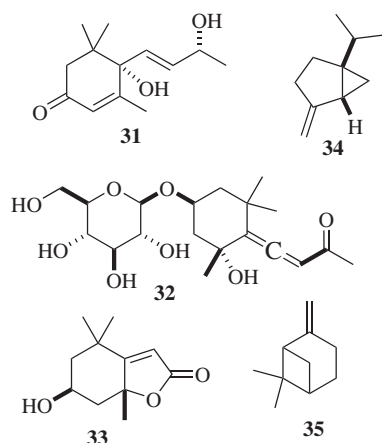


Figure 9: Some terpenoids present in curry leaves

Linalool **36**, α -humulene **37**, *trans*-piperitol **38**, nerolidol **39** are some of the volatile compounds

extracted from curry leaves (Figure 10) [8,13].

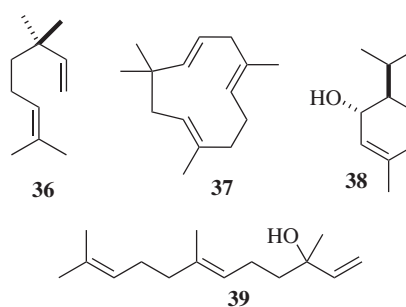


Figure 10: Some volatiles present in curry leaves

Curry leaf plant is rich in some other phytochemicals such as polyphenols (e.g., gallic acid **40**, ferulic acid **41**, vanillic acid **42**, Figure 11), amino acids, vitamins (A, C, E, B₁₋₃), and minerals such as Ca, K, Mg, P, Fe, Mn, Se and Zn, and lipids [2,3].

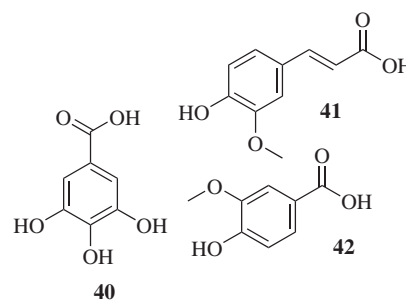


Figure 11: Some polyphenols present in curry leaf plant

Health benefits of curry leaves

South Asian women add curry leaves to their cuisines because of its ability to increase the food appetite and digestion. In folk medicine, curry leaves are applied as the treatment to bruises, eruption, and for bite wounds of poisonous animals. Porridge of curry leaves is recommended to cure piles, reduce the body heat, quench thirst, reduce inflammation, and reduce itching, due to the anti-inflammatory properties [1,13].

Recently scientists have discovered that mahanine and pyrayafoline-D show anti-cancer and anti-microbial properties, while girinimbine in the roots, stem bark, and seeds is an effective medicine to cure tumors. Not only alkaloids, but also flavonoids (e.g., quercetin, catechin, epicatechin, naringin, rutin, etc.) are strong anti-cancer compounds present in this plant. 9-Formyl-3-methyl carbazole, koenine, koenigine, mahanimboline, mukoeic acid, murrayanine, quercetin, catechin, epicatechin, naringin, rutin are some examples

for antioxidants which protect cells from free-radicals [8,13].

According to the traditional knowledge, most of the Indians believe that curry leaves purify the surrounding. It gives sense to the anti-microbial and anti-viral nature of curry leaves (e.g., essential oils present in leaves such as allo-ocimene, A-terpinene, (E)- β -ocimene, elemol, geranyl acetate). Recently, scientists have found essential oil (which contains β -phellandrene, z-caryophyllene, α -pinene, sabinene and isodaucene) extracted from curry leaves can be used as an insecticide against *Aedes aegypti* due to its larvicidal activity [3].

Curry leaves are well known medicine for obesity and high cholesterol level. Curry leaf plant is a medicine for many diseases including, diabetes, obesity, bronchial disorders, Alzheimer disease, gastrointestinal disorder, cardiovascular diseases, liver diseases, kidney diseases etc. [4,6,7,13].

According to the ancient Indian literature (Ramayanaya), Hanuma had used curry leaves to heal the wounds of God Rama's soldiers who were injured during Rama-Ravana war. It is evident that sweet neem leaves or curry leaves provide protection and longevity to life timelessly.

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Guest Articles

Impact of marijuana on human brain

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What is marijuana?

Marijuana, which is commonly called “pot, weed or Mary Jane” is a flowering plant in the *Cannabaceae* family. *Cannabaceae* family includes about 170 different species distributed among 11 genera, such as, *Cannabis*, *Humulus*, *Celtis*, *Aphananthe*, *Chaetachme*, *Gironniera*, *Lozanella*, *Parasponia*, *Pteroceltis*, *Moraceae* and *Trema*.¹ The genus *Cannabis* is famous for its two species *Cannabis sativa* and *Cannabis indica*. *Cannabis sativa* is commonly known as hemp, and it is also valued for its fibers, seeds and oil. *Cannabis indica* plants usually grows shorter and denser with wider leaves and higher THC (tetrahydrocannabinol) levels than the sativa plants. It is said that sativa plants are often associate with more energizing and stimulating effect on brain while indica species gives a sedative feeling. However, the effect of these plants does not completely depend on its species, but on the chemical composition of the plant as well. Apart from these two species, sativa and indica plants are also crossbred to create hybrid species, *Cannabis ruderalis*. This species exhibits a mixture of properties of its parent plants. They are also known as auto flowering plants as they can flower under any type of light, unlike photoperiodic sativa and indica species.² Figure 1 shows the physical differences between the species *Cannabis sativa*, *Cannabis indica* and *Cannabis ruderalis*.

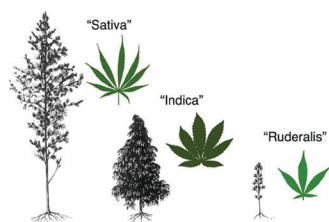


Figure 1: *Cannabis sativa*, *Cannabis indica* and *Cannabis ruderalis*.³

How is Marijuana used?

The delivery method of marijuana is important to optimize the mental and physical effects for medical marijuana users and for people using it recreationally, whether legally or not. Marijuana can be used in many ways; smoking, oral and topical are the three basic delivery methods that are been used. Marijuana smokers usually use hand rolled cigarettes called joints or water pipes which are called bongs. Some users also use marijuana blunts to smoke. These are made by replacing the tobacco in cigars by marijuana, often combining it with cocaine for more stimulation.¹ Oral delivery involves mixing marijuana with food, brew with tea or placing marijuana-infused tincture or hash oil capsule under the tongue.² The effects of the drug is felt immediately when it is smoked, however when the drug is ingested it can take up to 90 minutes to feel the effect. This effect can last from 2 to 6 hours depending on the dosage and the person. When taken in high doses, high anxiety, delusions, paranoia, and hallucinations is often experienced.⁴ Applying marijuana cream/lotion directly on the skin is known as tropical delivery. It has proven that reapplying marijuana cream/lotion frequently can help to relieve the arthritis pain. Transdermal patches can also be used in this case to deliver the correct dose of the medication to the affected area. It is very important to choose the correct delivery method and the dose for a given situation as the impact varies accordingly.⁵

Composition of marijuana

The composition of marijuana consists of more than 500 different compounds, and they can be categorized into four main groups. They are