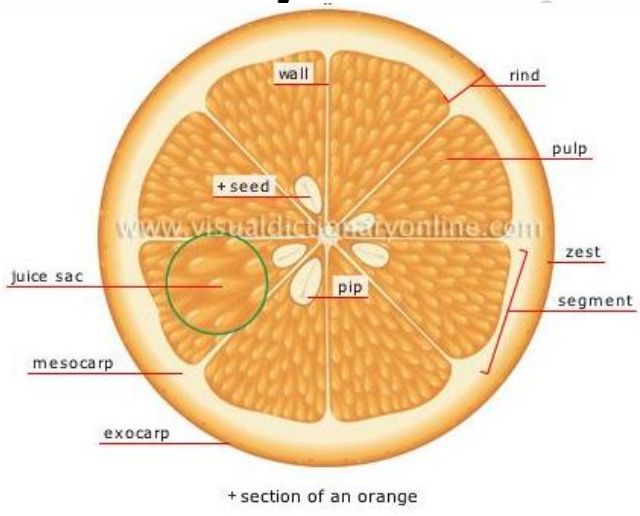
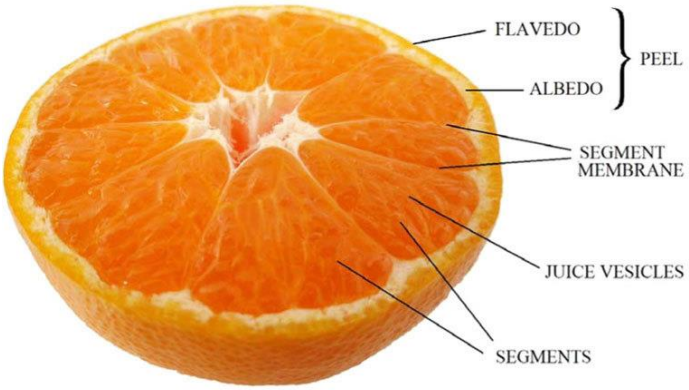
Lesson no. 27 Citrus fruits.

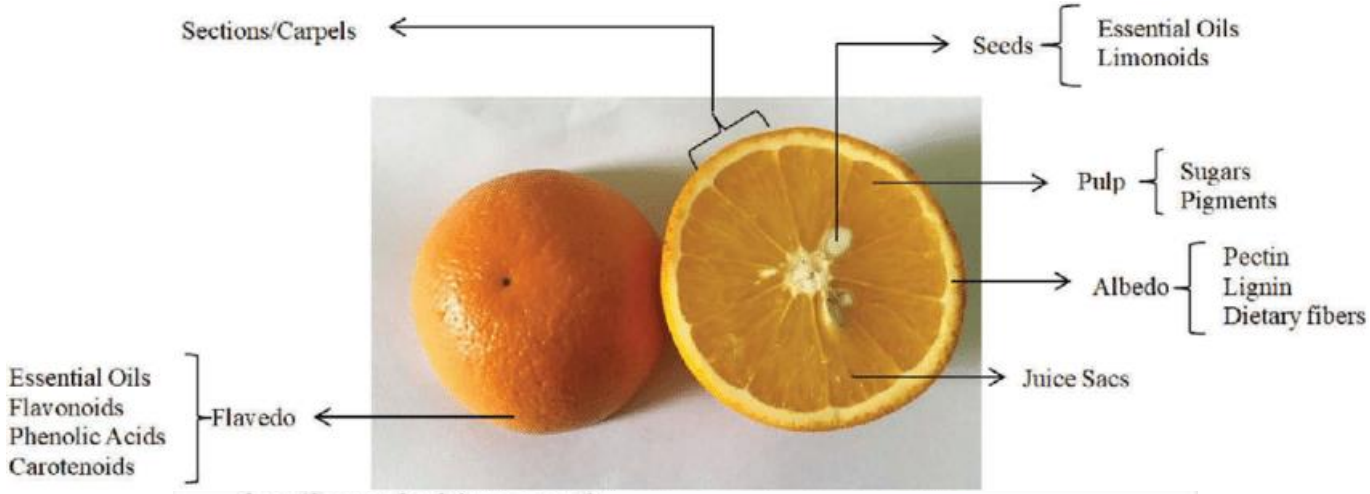


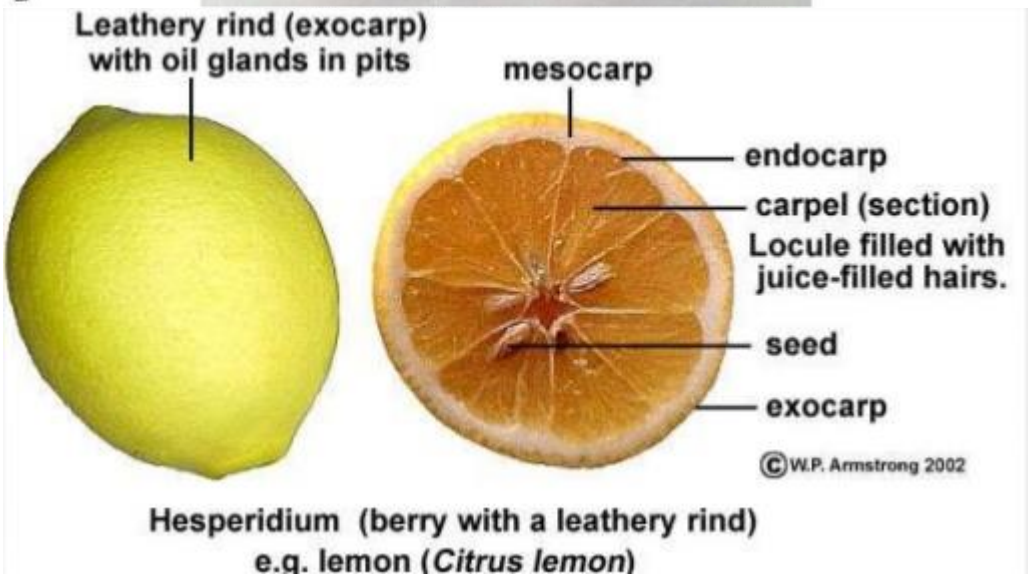
+ section of an orange



Citrus fruits are group fruits of different shapes, size, taste from same family; they are eaten worldwide & easy available, harvested, cultivated, cheap; they has a lot of health benefits; I will Insha-Allah explain the important citrus fruits separately each in this lesson; first let us learn the common information of citrus fruits; they belong from Rutaceae family; the important citrus fruits are oranges, lemons, grapefruits, pomelos, citrons and limes; the genus Citrus is native to South Asia, East Asia, Southeast Asia, Melanesia, and Australia & other parts of the world subtropical and tropical

regions; Citrus fruits and plants collectively are also known by the Romance loanword agrumes (literally "sour fruits"). These plants are large shrubs or small to moderate-sized trees, reaching 5–15 m (16–49 ft) tall, with spiny shoots and alternately arranged evergreen leaves with an entire margin. The flowers are solitary or in small corymbs, each flower 2–4 cm (0.79–1.57 in) diameter, with five (rarely four) white petals and numerous stamens; they are often very strongly scented. The fruit is a hesperidium, a specialized berry, globose to elongated, 4–30 cm (1.6–11.8 in) long and 4–20 cm (1.6–7.9 in) diameter, with a leathery rind or "peel" called a pericarp. The outermost layer of the pericarp is an "exocarp" called the flavedo, commonly referred to as the zest. The middle layer of the pericarp is the mesocarp, which in citrus fruits consists of the white, spongy "albedo", or "pith". The innermost layer of the pericarp is the endocarp. The space inside each segment is a locule filled with juice vesicles, or "pulp". From the endocarp, string-like "hairs" extend into the locules, which provide nourishment to the fruit as it develops. Many citrus cultivars have been developed to be seedless and easy to peel. Citrus fruits are notable for their fragrance, partly due to flavonoids and limonoids (which in turn are terpenes) contained in the rind, and most are juice-laden. The juice contains a high quantity of citric acid giving them their characteristic sharp flavour. The genus is commercially important as many species are cultivated for their fruit, which is eaten fresh, pressed for juice, or preserved in marmalades and pickles. They are also good sources of vitamin C. The content of vitamin C in the fruit depends on the species, variety, and mode of cultivation. Fruits produced with organic agriculture have been shown to contain more vitamin C than those produced with conventional agriculture in the Algarve, but results depended on the species and cultivar. The flavonoids include various flavanones and flavones.





In Hadith Atraj word has been used it can be for sweet orange or mandarin; in Hadith of Bukhari: 5427 it is mentioned that-A believer who recites the Qur'an is like an orange whose fragrance is sweet and whose taste is sweet; it also mentioned in other book of Hadith Jamius Sageer volume 2 page 139 & Mojam Ausat: 9404; for more detail study on Atraj (sweet oranges or mandarin) please visit my website www.tib-e-nabi-for-you.com or direct link to lesson citrus fruits (Atraj) at http://www.tib-e-nabi-for-you.com/citric%20fruits.html or read my English book Tibb e Nabawi part 2 lesson no. 34 page 56 onwards. We will start with each citrus fruit below.

- ***Basic encyclopedia of oranges: -***

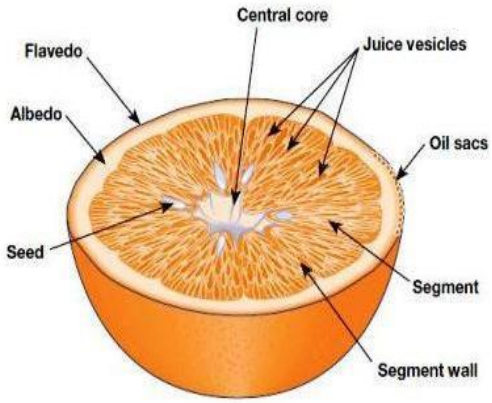
Orange fruits are on many types as per species & as per different regions; sweet orange is botanically called as Citrus sinensis & bitter is called as Citrus aurantium; sweet orange reproduces asexually; The orange is a hybrid between pomelo (*Citrus maxima*) and mandarin (*Citrus reticulata*); Orange trees are widely grown in tropical and subtropical climates for their sweet fruit. The fruit of the orange tree can be eaten fresh, or processed for its juice or fragrant peel; 70% of citrus production is from sweet oranges; it belongs to Rutaceae family.

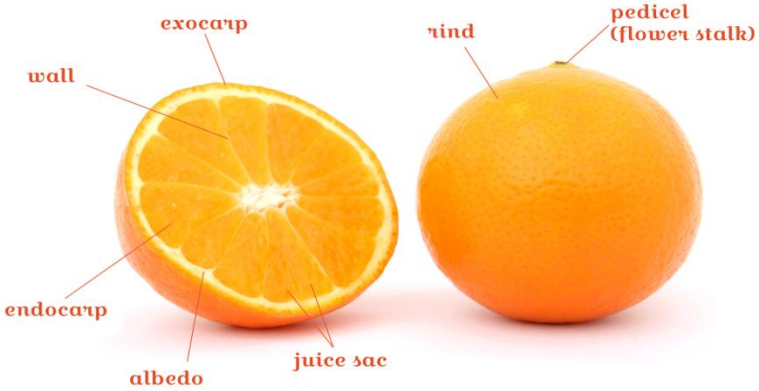
- ***Orange tree, leaves & flower: -***

The orange tree is an evergreen, flowering tree, with an average height of 9 to 10 m (30 to 33 ft), although some very old specimens can reach 15 m (49 ft). Its leaves are oval, alternately arranged, are 4 to 10 cm (1.6 to 3.9 in) long and have crenulate margins. Sweet oranges grow in a range of different sizes and shapes varying from spherical to oblong. The flower is white coloured; 5 petals; the flower bloom into fruit. Orange tree starts producing fruit at 3 years old, long before fully grown height. A fully grown and developed orange tree may be 20 to 30 feet tall. For the first two to three years of production, called the juvenile phase, orange trees may produce a smaller number of large, thick-skinned fruit. Most orange flowers do not turn into fruit and drop from the tree at the end of the bloom. Two of the most common cultivars are the early-season navel orange and late-season Valencia orange. Flower bloom into orange fruit, but not all flowers; as the tree blooms it produces orange fruit till 7 to 15 months. After the flowers bloom, navel oranges take seven to 12 months and 'Valencia' oranges take 12 to 15 months to ripen. Due to the length of the maturing process, 'Valencia' trees can carry both mature and developing oranges at the same time.

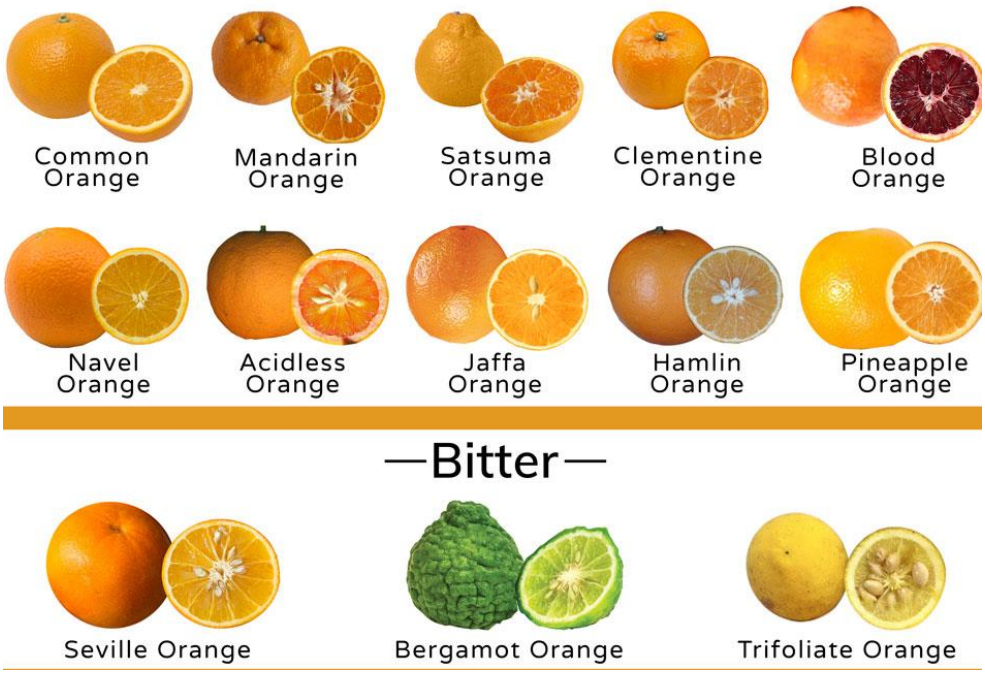

- ***Orange Fruit: -***

Orange fruit are of various shapes, size & taste depending on the harvesting method & different regions; parts of the fruit are:





The orange contains a number of distinct *carpels* (segments) inside, typically about ten, each delimited by a membrane, and containing many juice-filled vesicles and usually a few seeds (*pips*). When unripe, the fruit is green. The grainy irregular rind of the ripe fruit can range from bright orange to yellow-orange, but frequently retains green patches or, under warm climate conditions, remains entirely green. Like all other citrus fruits, the sweet orange is non-climacteric. It is subdivided into four classes with distinct characteristics: common oranges, blood or pigmented oranges, navel oranges, and acid-less oranges. Blood oranges are a natural mutation of although today the majority of them are hybrids. High concentrations of anthocyanin give the rind, flesh, and juice of the fruit their characteristic dark red color. Acid-less oranges are an early-season fruit with very low levels of acid. Common oranges (also called "white", "round", or "blond" oranges) constitute about two-thirds of all the orange production. The majority is used mostly for juice extraction. Navel oranges are characterized by the growth of a second fruit at the apex, which protrudes slightly and resembles a human navel. They are primarily grown for human consumption for various reasons: their thicker skin makes them easy to peel, they are less juicy and their bitterness – a result of the high concentrations of limonin and other limonoids – renders them less suitable for juice. Peel color in an orange does not necessarily indicate it's ready to eat. Navel oranges turn from green to orange long before they are sweet, and 'Valencia' oranges sometimes redevelop a green color after the spring growth flush. In India orange of Nagpur are very famous; the Nagpur oranges blossom during the Monsoon season and are ready to be harvested from the month of December. The orange crop here grows twice a year. The fruit available from September to December is Ambiya which has a slightly sour taste. It is followed by the sweeter Mrig crop in January. Oranges are grown extensively in Nagpur because the condition there is appropriate also the weather is warm, the soil is black etc.



- ***Bitter orange: -***

Bitter orange is also called as Seville orange, sour orange, bigarade orange, or marmalade orange; its botanical name is *Citrus aurantium;* it is among Rutaceae family many varieties of bitter orange are used for their essential oil, and are found in perfume, used as a flavoring or as a solvent and also for consumption. Bitter orange is used in herbal medicine as a stimulant and appetite suppressant, due to its active ingredient, synephrine.

- ***Orange oil: -***

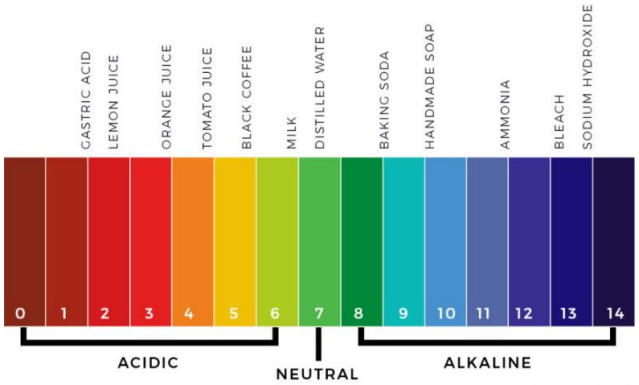
Orange Oil, most commonly referred to as Sweet Orange Essential Oil, is derived from the sweet oranges, leaves, peel or flower all separate or mixed. And bitter orange essential oil is derived from bitter oranges, leaves, peel, flowers separately or mixed. It contains 90% d-limonene & it have lot of benefits. Read below clinical pharmacology.

- ***pH of orange is: -*** pH of sweet orange is between 3 to 4 & pH of bitter orange is 4.5; both are acidic because its pH is below 7.

pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14. Aqueous solutions at 25°C with a pH less than 7 are acidic, while those with a pH greater than 7 are basic or alkaline & 7 is neutral; only aqueous solutions have pH levels, vegetable oil has no pH value. Likewise, other oils such as animal and petrochemical oils also have no pH value. Fatty acids are organic molecules often found in foods, including vegetable oils.

The pH of pure water is 7. In general, water with a pH lower than 7 is considered acidic, and with a pH greater than 7 is considered alkaline. The normal range for pH in surface water systems is 6.5 to 8.5, and the pH range for groundwater systems is between 6 and 8.5. We can add normal water to reduce the acidity.

It is Sunnat of Prophet Muhammad (s.a.w) to mix acidic with Alkaline to make it neutral or less acidic that why He use eat dates with watermelon or cucumber or dry dates with little butter; so you can mix one acidic with alkaline; also it is Sunnat to drink honey mixed in water; also dates or raisins soaked in water over night & drink the syrup (sharbat). Remember do not soak dates & raisin together at one time; soak at separate time & drink.



- ***Calories of orange: -*** 100 grams of sweet orange gives 47 calories & 100 gram of bitter orange gives 24 calories.
- ***Glycemic index & Glycemic load: -*** glycemic index of sweet & bitter orange is 40 to 43 & glycemic load is 3 to 4 only; so GI & GL is low; diabetic patients can eat it.

A food is considered to have a low Glycemic index (GI) if it is 55 or less; mid-range GI if 56 to 69 & high GI if 70 or more. Glycemic index is a number. It gives you an idea about how fast your body converts the carbs in a food into glucose.

A low Glycemic load (GL) is between 1 and 10; a moderate GL is 11 to 19; and a high GL is 20 or higher. For those with diabetes, you want your diet to have GL values as low as possible.

The glycemic load (GL) of food is a number that estimates how much the food will raise a person's blood glucose level after eating it. Glycemic load accounts for how much carbohydrate is in the food and how much each gram of carbohydrate in the food raises blood glucose levels.

- ***Gross health benefits of orange: -***

Sweet orange contains large amounts of vitamin C. Some researchers believe sweet orange might help asthma because of the antioxidant activity of vitamin C. Sweet orange also contains large amounts of potassium. There is evidence that potassium may help prevent high blood pressure and stroke. It is helpful in cold & cough; recovery from dengue, typhoid etc. Good for hair, nails, digestion, helpful in piles, it regulates heart beat, increases complexion, reduces freckles on skin, expels gases, helpful in diabetes, Scurvy disease etc. Bitter orange is believed by some to treat angina, allergies, insomnia, nasal congestion, nerve pain, poor appetite, and liver and gallbladder problems. Many of the benefits are attributed to a compound in bitter orange known as synephrine. Experimental evidences highlight their pharmacological effects including antioxidant, cardio-protective, anti-proliferative, anticancer, and hypo-lipidemic activities

- ***Clinical pharmacology of bitter & sweet orange & its essential oil: -***

Bitter orange (Citrus aurantium) is called with several local common names in different countries where it is used for food, fragrance, and medical application. Fruit, peel, leaves, flowers, seeds, and essential oil (EO) of it are used in perfumes, cosmetics, as well as in the food and confectionery industry. Bitter orange oil, obtained from the pressure of the fresh peels, is widely used as a flavoring agent in the food industry and for beverages, particularly liqueurs and soft drinks. The composition of the volatile oils is significantly different in flowers, leaves, and peel. Linalyl acetate (50%) is the main constituent in oil from the leaves (petit grain), and linalool (35%) in oil is derived from the flowers (neroli), Flavones, alkaloids such as synephrine and octopamine, carotenoids, and N-methyltyramine are contained in peel, besides the volatile oil. The main active ingredient in bitter orange extract is the phenyl-ethylamine protoalkaloid p-synephrine which represents about 90% or more of the total protoalkaloids. Fruit peel contains a volatile oil composed of d-limonene, d-linalool, N-acetyl octopamine, gamma-aminobutyric acid, flavonoids, coumarins, triterpenes, vitamin C, carotene, and pectin. Other minor protoalkaloidal constituents in Citrus aurantium octopamine, hordenine, tyramine, and N-methyltyramine are absent or

in trace amounts in bitter orange extracts. Both reduces anxiety, stress & helpful in insomnia (lack of sleep).

Sweet orange (Citrus sinensis) contains several active secondary metabolites contributing to the pharmacological activities of the plant. In it fruits, peel, leaves, juice and roots, several types of chemical compounds including flavonoids, hydroxyamides, steroids, alkanes and fatty acids, coumarins, carbohydrates, peptides, carbamates and alkylamines, carotenoids, volatile compounds, and minerals such as potassium, magnesium, calcium, and sodium have been identified. Sweet orange is a rich source of vitamin C, a natural antioxidant that support the immune system activity, intestinal disorders (such as cramps, constipation, colic, and diarrhea), respiratory disorders (such as cough, cold, bronchitis, and tuberculosis), obesity, menstrual disorder, cardiovascular disease (angina, hypertension), anxiety, depression, and stress. Anxiety disorders are among the leading prevalent causes of global mental disorders. It is known that inhalation of volatile components of sweet orange oil is helpful in activity of brain areas such as the hypothalamus, hippocampus, and pyriform; preclinical and clinical research showed that citrus fragrance can restore stress-induced cortex and immune-suppression and may have potential antidepressant effects in rats.

In light of the above mentioned findings, we tried to assess if the potential health effects of both Citrus aurantium and Citrus sinensis are really effective in the treatment of anxiety conditions. Sweet orange oil also known as neroli oil, is widely used in aromatherapy. It has been suggested that it stimulates central nervous system, lowers blood pressure, and has sedative, analgesic, anti-inflammatory, antispasmodic, carminative, digestive, and diuretic effects.

- ***Modern uses of it: -***

Steam inhalation with orange oil: -

Its oil can used in steam inhalation with other oil for anxiety, stress, lack of sleep; take few drops of pure orange oil any sweet or bitter add in little warm water, also add few drops of pure marjoram oil & take the steam inhalation twice a day till complete relief; it can be take for cough & cold, respirative diseases.

For maintenance of health: -

Take half sweet orange of big size or one sweet orange of medium size add little salt on it & little honey & eat it empty stomach early morning once or twice a week.

For recovery from diseases: -

Take one sweet orange, one small beetroot, one dried or fresh fig, 7 seeds of black caraway & 7 seeds of fenugreek add 100 ml water in it & grind in mixer to make a juice & drink once or twice a day till complete relief; always try to prepare fresh juice & drink.

For hair & skin problems: -

Take its oil 11 drops in 20ml of extra virgin olive oil, also take 1 teaspoon aloe vera gel mix all & apply the paste on hair, skin, face or effected part of skin; complexion will increase, skin & hair will get health & wound will heal.

- ***Contents/constituents of it: -***
- ***Bitter orange: -***

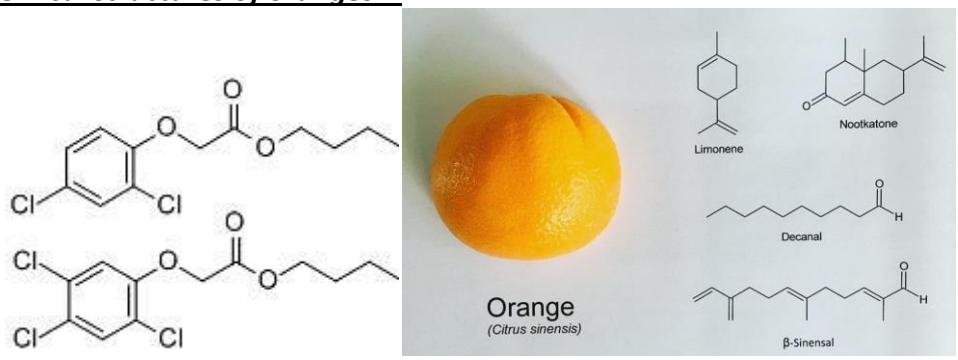
Linalyl acetate (50%) is the main constituent in oil from the leaves of bitter orange, and linalool (35%) is in oil derived from the flowers (neroli) of bitter orange, Flavones, alkaloids: synephrine and octopamine, carotenoids, and N-methyltyramine are contained in peel, besides the volatile oil. The main active ingredient in bitter orange extract is the phenyl-ethylamine protoalkaloid p-synephrine which represents about 90% or more of the total protoalkaloids. Fruit peel contains a volatile oil composed of d-limonene, d-linalool, N-acetyl octopamine, gamma-aminobutyric acid, flavonoids, coumarins, triterpenes, vitamin C, carotene, and pectin, octopamine, denine, tyramine, N methyl-euramine,

- ***Sweet orange: -***

fruits, peel, leaves, juice and roots have flavonoids, hydroxyamides, steroids, alkanes and fatty acids, coumarins, carbohydrates, peptides, carbamates and alkylamines, carotenoids.

In 100 grams of both orange fruit contains: water 87%, protein 0.9 gram, carbs 11.8 gram, sugar (fructose, glucose, sucrose), fiber 2.4 grams (lignin, hemicelluloses, pectin, cellulose); hesperidin, anthocyanin, carotenoid, beta-crptoxanthin, lycopene, citric acid, citrate, pinene, myrcene, phellandrene, carnene, terpinene, limonene, carvone, damascenone, ionone, butanoate, linalool, octanol, vitamin A, C, E, B1, B2, B3, B5, B6, B9, choline, calcium, iron, magnesium, manganese, phosphorus, potassium, zinc.

- ***Main chemical structures of oranges: -***



Oranges, all commercial varieties	raw,
Nutritional value per 100 g (3.5 oz)	
Energy	197 kJ (47 kcal)
Carbohydrates	11.75 g
Sugars	9.35 g
Dietary fiber	2.4 g
Fat	0.12 g
Protein	0.94 g
Vitamins	Quantity%DV†
Vitamin A equiv.	1% 11 µg
Thiamine (B1)	8% 0.087 mg
Riboflavin (B2)	3% 0.04 mg
Niacin (B3)	2% 0.282 mg
Pantothenic acid (B5)	5% 0.25 mg
Vitamin B6	5% 0.06 mg
Folate (B9)	8% 30 µg
Choline	2% 8.4 mg
Vitamin C	64% 53.2 mg

Vitamin E	1% 0.18 mg
Minerals	Quantity % DV†
Calcium	4% 40 mg
Iron	1% 0.1 mg
Magnesium	3% 10 mg
Manganese	1% 0.025 mg
Phosphorus	2% 14 mg
Potassium	4% 181 mg
Zinc	1% 0.07 mg
Other constituents	Quantity
Water	86.75 g

Lemon: -

Lemon are widely used in cooking, salad, juices, vinegar, tea, pickles etc worldwide; it is native to south Asia & Northern India (Assam); its botanical name is Citrus limon & belongs to Rutaceae family; it is of many types depending on different regions some are small round, oval, big oval etc & they differ little in taste though all are sour & rich in citric acid & vitamin C; they add taste in food, promote energy to the body, also have medicinal properties for common cold, flu, viral infections etc. It is peel also has

medicinal properties & often used to make pickles. Its fruit juice is best in summer season & get costly in summer & cheap in rainy reason.

- ***Lemon tree & flower: -***

The lemon tree has a spreading, upright growth habit, flowering, evergreen, few large branches and stiff thorns. The tree possesses large, oblong or oval, light green leaves and produces bisexual flowers of purple-white colour in clusters. Lemon trees can reach 3–6 m (10–20 ft.) in height and can live for many years, reaching full fruit-bearing capacity in approximately 40 years. Lemon seeds can be successfully propagated, even from store-bought fruit. There is a drawback to using seed harvested from commercial fruit. The parent plant may be a hybrid, with a greater chance that the seed will produce a sterile tree. Lemon trees (Citrus Limon) may sport flowers and fruit at the same time. Dwarf lemon trees reach 6 to 15 feet tall, depending on the variety, while standard trees can grow as large as orange trees. Best time of transplanting is September, October, & February, March. Lemon tree are subtropical; they grow well in warm climates, thrive in temperature between 77 & 86 degrees Fahrenheit; for best growth it needs soil of 6 to 7.5 pH; it tolerates dry soil conditions but not wet clay-heavy soil. The leaves of the lemon tree are used to make a tea and for preparing cooked meats and sea-foods.


- ***Lemon fruit & peel oil: -***


The lemon fruit is an ellipsoid berry, surrounded by a green rind, which ripen to yellow, protecting the soft yellow segmented pulp inside. Lemon fruit ripen anywhere between 4 to 12 months after flowering, flowers most commonly appear in spring; fruits develop in summer & turn green to yellow in winter; the fruit contains sour taste juice in it with a pH of 2.2; this sour juice has 5 to 6 % citric acid & vitamin C in it; the fruit is of many types different of different regions, some have thick peel some have thin peel; some are round small or medium size; some are oval long & big in size; but all have sour juice in it; lemon juice, rind, and peel are used in a wide variety of foods and drinks. The whole lemon is used to make marmalade, lemon curd and lemon liqueur. Lemon slices and lemon rind are used as a garnish for food and drinks. Lemon zest, the grated outer rind of the fruit, is used to add flavor to baked goods, puddings, rice, and other dishes. Lemon juice is used to make lemonade, soft drinks, and cocktails. It is used in marinades for fish, where its acid neutralizes amines in fish by converting them into nonvolatile ammonium salts. In meat, the acid partially hydrolyzes tough collagen fibers, tenderizing the meat, but the low pH denatures the proteins, causing them to dry out when cooked. Lemon juice is also

used as a short-term preservative on certain foods that tend to oxidize and turn brown after being sliced (enzymatic browning), such as apples, bananas, and avocados, where its acid denatures the enzymes. Lemon oil is extracted from oil-containing cells in the peel. A machine breaks up the cells, and uses a water spray to flush off the oil. The oil/water mixture is then filtered and separated by centrifugation. Its peel oil is very beneficial for health & used in aroma therapy.

- ***pH of lemon juice is: -*** 2.2; it is acidic because its pH is below 7.
- ***Calories of lemon water: -*** one glass of water added with little lemon juice give only 6 calories & 100 grams of lemon juice gives 26 calories; honey-lemon tea 2 to 3 teaspoon gives 71 calories.
- ***Glycemic index & Glycemic load lemon juice:-***

Glycemic index of lemon juice is 25 which is low & good for diabetic patients for consume it & glycemic load is only 3 out of 120 grams of lemon juice which is low & good for diabetes.

- ***Gross health benefits of lemon juice, tea, lemon water: -***

It is beneficial in diabetes because of low glycemic index & load; best for common cold, flu, viral cold; it is a strong antioxidant, best for asthma, lungs infection, digestive disorders, good for skin, hair & nails; it reduces risk of stroke; help in controlling high blood pressure; Cancer prevention; maintaining a healthy complexion; helps in preventing asthma; Increasing iron absorption; Boosting the immune system; helps in weight loss; prevents kidney stones, keep hydrated in summer; boost energy; best during loose motions, sports etc; it is natural anti-bacterial, antiviral & antifungal, anti-inflammatory; very helpful in scurvy disease etc.

- ***Clinical pharmacology of lemon: -***

Acetone extracts from *C. limon* fruits have shown inhibitory activity against the Gram-positive bacteria *Enterococcus faecalis* (MIC 0.01 mg/mL) and *Bacillus subtilis* (MIC 0.01 mg/mL), and the Gram-negative *Salmonella typhimurium* (MIC 0.01 mg/mL) and *Shigella sonnei* (MIC 0.01 mg/mL).

The *C. limon* essential oil exhibits inhibitory activity against *Staphylococcus mutans* (MIC 4.5 mg/mL) and effectively reduced the adherence of *S. mutans* on a glass surface.

Ethanol and acetone extracts from fruits of *C. limon* were active against *Candida glabrata* (MIC 0.02 mg/mL). On the other hand, *C. limon* essential oil ingredients, such as D-limonene, β-pinene and citral, have shown inhibitory activity against *Aspergillus niger* (MIC 90 µL/mL at 70 °C), *Saccharomyces cerevisiae* (MIC 4 mg/mL) and *Candida parapsilosis.* The effect of *C. limon* essential oil on *Sarcoptes scabiei* var. *cuniculi* has been evaluated in vitro and in vivo. Aqueous extracts from the peel of *C. limon* fruits have been used to investigate their effects on the release of histamine from rat peritoneal exudate cells.

An ethanolic extract of *C. limon* fruits has been evaluated for its effects on experimental liver damage induced by carbon tetrachloride (CCl_4), and the ethyl acetate soluble fraction of the extract has been evaluated for its effect on the HepG2 cell line (human liver cancer cell line). The ethanolic extract (150 mg/mL) normalized the levels of aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT), alkaline phosphatase (ALP), and total direct bilirubin.

- ***Modern uses of it: -***
- **For obesity, preventing diseases: -**

Take 1 300 ml of water, cut 1 small size lemon in piece & soak it the water, add little salt, & boil it on low flame for some time & than add 1 spoon of pure honey & drink in luke warm condition on empty stomach daily for 11 days followed by twice a week for 3 months.

- **For prevent of heart diseases, to reduce cholesterol:-**

Take one small size lemon cut into small pieces & soak in 1 big glass water, cut 1 clove of garlic & small piece of ginger & soak in the same water, add little beetroot cut in small pieces & now boil the water little on low flame & put 1 spoon of honey in it & drink it on empty stomach early morning once or twice a week lifelong.

- ***Biological activity of* C. limon *fruit extracts confirmed by scientific research.***

Activity	Mechanism of Action

Activity	Mechanism of Action
Anticancer activity	Inhibition of the proliferation of cancer cells; Activation of "TRAIL"-apoptopic cell death; Inhibition of tumour growth in chronic yelogenous leukaemia (CML); Antioxidant action and induction of apoptosis in MCF-7 cells (breast adenocarcinoma cells) (C. limon seed extract).
Antioxidant activity	Augmention of antioxidant cellular defences via ERK/Nrf2 signalling pathway.
Anti-inflammatory activity	Inhibition of NF-κB factor, nitric oxide (II) synthase (iNOS), induced cyclooxygenase (COX-2) (hesperidin, hesperitin); Down-regulation of TLR-signaling pathway (limonin).
Antibacterial activity	Inhibiting activity against Gram-positive bacteria: Enterococcus faecalis, Bacillus subtilis; Inhibiting activity against Gram-negative bacteria: Salmonella typhimurium, Shigella sonnei, Helicobacter pylori.
Antifungal activity	Inhibiting activity against Candida glabrata strains.
Antiviral activity	Inhibition of replication of Herpes simplex.
Anti-allergic activity	Inhibition of histamine secretion in peritoneal cells of rats.
Hepatoregenerative activity	Normalization of alanine aminotransferase (ALAT), alkaline phosphatase (ALP) and bilirubin; Reduction in malonic dialdehyde (MDA), lipid peroxidation, superoxide dismutase (SOD) and catalase.
Prevention of diabetes and treatment of its symptoms	Inhibition of gluconeogenesis (naringenin, hesperitin); Inhibition of gluconeogenesis (naringenin, hesperitin); Reducing wound-healing time; Increasing tissue growth rate, collagen synthesis, and protein and hydroxyproline concentration.
Anti-obesity activity	Lowering blood lipids; Reducing the levels of insulin, leptin and adiponectin in the blood.
Effects on the cardiovascular system	Limiting myocardial damage (naringenin); Decreasing blood fibrinogen; Lowering blood pressure in people with hypertension.
Effects on the nervous system	Strengthening short-term memory.
Effects on the respiratory system	Treatment of chronic pneumonia (naringenin).
Effects on the skeletal system	Increasing bone density; Decreasing osteoclast activity; Decreasing TRAP-positive multinucleated cell numbers (nomilin); Decreasing bone resorption activity (nomilin); Down regulation osteoclast-specific genes (NFATc1 and TRAP mRNA levels) (nomilin).
Treatment of menstrual disorders	Period induction in cases of irregular menstrual cycles.

- ***Contents/constituents of lemon: -***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc.

- ***Composition of C. lemon fruits extracts: -***

Group of Compounds	Part of Fruit	Metabolites
Flavonoids	Whole fruit (pulp, seed and peel)	flavonones: eriocitrin, eriodiktyol, hesperidin, naringin, neoeriocitrin, neohesperidin
		flavones: apigenin, diosmetin, diosmin, homoorientin, luteolin, orientin, vitexin
		flavonols: isoramnethin, quercetin, limocitrin, rutoside, spinacetin
Limonoids	Whole fruit (pulp, seed and peel)	limonin, nomilin
Phenolic acids	Whole fruit (pulp, seed and peel)	dihydroferulic acid, p-hydroxybenzoic acid, 3-(2-hydroxy-4-methoxyphenyl)propanoic acid, synapic acid
Carboxylic acids	Whole fruit (pulp, seed and peel)	citric acid, galacturonic acid, glucuronic acid, glutaric acid, homocitric acid, 3-hydroxymethylglutaric acid, isocitric acid, malic acid, quinic acid
Coumarins	Whole fruit (pulp,	citropten (5,7-dimethoxycoumarin), scopoletin

Group of Compounds	Part of Fruit	Metabolites
	seed and peel)	
Furanocoumarins	Whole fruit (pulp, seed and peel)	bergamottin
Amino acids	Whole fruit (pulp, seed and peel)	L-alanine, L-arginine, L-asparagine, L-aspartic acid, dimethylglycine, glutamic acid, L-phenylalanine, DL-proline, L-tryptophan, L-tyrosine, L-valine
Carbohydrates	Peel	monosaccharides: arabinose, fructose, β-fructofuranose, β-fructopyranose, galactose, glucose, mannose, myoinositol, rhamnose, scylloinositol, xylose
	Whole fruit (pulp, seed and peel)	disaccharides: sucrose
Vitamins and theirs metabolites	Whole fruit (pulp, seed and peel)	choline, pantothenic acid, trigoneline, vitamin C
Macroelements	Pulp and peel	calcium (Ca), magnesium (Mg), phosphorus (P), potassium (K), sodium (Na)

- ***The chemical composition of the essential oil of the C. limon pericarp and leaf.***

Group of Compounds	Essential Oil	Metabolites
Terpenoids	essential oil of the C. limon pericarp	limonene (69.9%), p-mentha-3,8-diene (18.0%), β-pinene (11.2%), γ-terpinene (8.21%), myrcene (4.4%), sabinene (3.9%), myrcene (3.1%) geranial (E-citral, 2.9%), neral (Z-citral, 1.5%), linalool (1.41%), α-pinene (1.1%), α-thujene (1.1%), β-bisabolene (0.5%) (E)-β-ocimene (0.4%), citronellol (0.3%), geraniol (0.2%), β-caryophyllene (0.2%), trans-muurala-4(14),5-diene (0.2%), α-terpinene (0.1%), terpinolene (0.1%), nonanal (0.1%), eucalyptol (0.1%); other terpenes below 0.06%: α-bisabolol, camphene, citronellal, citronellyl acetate, β-curcumene, γ-curcumene, p-cymene, 7-epi-sesquithujene, α-farnesene, α-felandren, cis-limonene, trans-limonene, octanal, octanal acetate, terpinen-4-ol, β-santalene, zonarene
	essential oil of the C. limon leaf	limonene (31.5%), sabinene (15.9%), citronellal (11.6%), linalool (4.6%), neral (4.5%), geranial (4.5%), (E)-β-ocimene (3.9%), myrcene (2.9%), citronellol (2.3%), β-caryophyllene (1.7%), terpne-4-ol (1.4%), geraniol (1.3%), α-pinene (1.2%),γ-terpinene (0.9%), sylvestrene (0.6%), α-terpineol (0.6%), isogeranial (0.4%), β-bisabolene (0.3%), germacrene B (0.3%), isospathulenol (0.3%), α-terpinene (0.2%), terpinolene (0.2%), isopulegol (0.2%), γ-terpineol (0.2%), decanal (0.2%), δ-elemene (0.2%), α-humulene (0.2%), α-cadinol (0.2%), epi-α-bisabolol (0.2%) cis-p-menth-2-en-1-ol (0.1%), isoneral (0.1%), γ-muurolene (0.1%), spathulenol (0.1%)
Furano-coumarins	essential oil of the C. limon pericarp	aprindine, bergamottin, bergapten, byakangelicol, byakangelicin, epoxybergamottin, 5- and 8-geranoxypsoralen, 8-geranyloxypsoralen, heraclenin, imperatorin, isoimperatorin, isopimpinellin, xanthotoxin, oxypucedanin, phellopterin, psoralen
Coumarins	essential oil of the C. limon pericarp	citropten, 5-geranyloxy-7-methoxycoumarin, herniarin, 5-isopentenyloxy-7-methoxycoumarin

- ***Composition of oil from C. limon seeds.***

Group of Compounds	Metabolites
Fatty acids	arachidonic acid, behenic acid, lignoceric acid, linoleic acid, linolenic acid, oleic acid, oleopalmitic acid, palmitic acid, stearic acid
Tocopherols	α-tocopherol, β-tocopherol, γ-tocopherol, δ-tocopherol
Carotenoids	β-carotene, β-cryptoxanthin, lutein

- ***Composition of C. limon juice.***
- ***Metabolites***

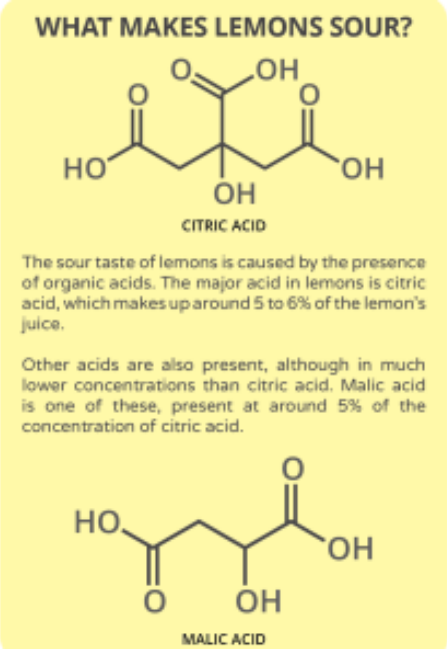
flavonones: hesperidin, naringin
flavones: apigenin, chrysoeriol, diosmetin, luteolin
flavonols: isoramnethin, quercetin, rutoside
dihydroxyflavonols: dihydroxyisoramnethin-7-O-rutinoside

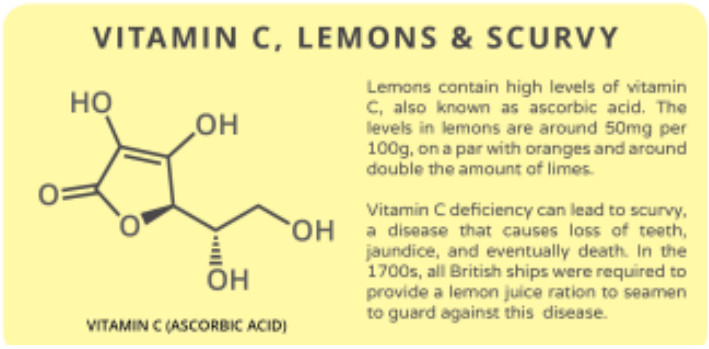
ferulic acid, synapic acid

vitamins: C (53 mg/L), A, B_1, B_2, B_3

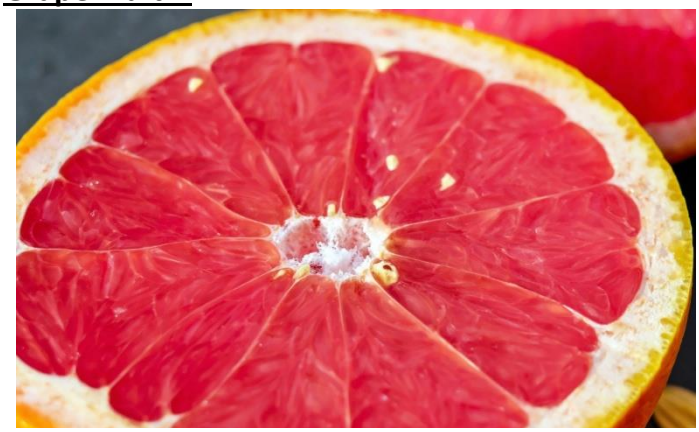
Lemon, raw, without peel	
Nutritional value per 100 g (3.5 oz)	
Energy	121 kJ (29 kcal)
Carbohydrates	9.32 g
Sugars	2.5 g
Dietary fiber	2.8 g
Fat	0.3 g
Protein	1.1 g
Vitamins	Quantity%DV†
Thiamine (B1)	3% 0.04 mg
Riboflavin (B2)	2% 0.02 mg
Niacin (B3)	1% 0.1 mg
Pantothenic acid (B5)	4% 0.19 mg
Vitamin B6	6% 0.08 mg
Folate (B9)	3% 11 µg
Choline	1% 5.1 mg
Vitamin C	64% 53 mg
Minerals	Quantity % DV†
Calcium	3% 26 mg
Iron	5% 0.6 mg
Magnesium	2% 8 mg
Manganese	1% 0.03 mg
Phosphorus	2% 16 mg
Potassium	3% 138 mg
Zinc	1% 0.06 mg

- ***Main chemcial structures of Lemon: -***





Grape-fruit: -



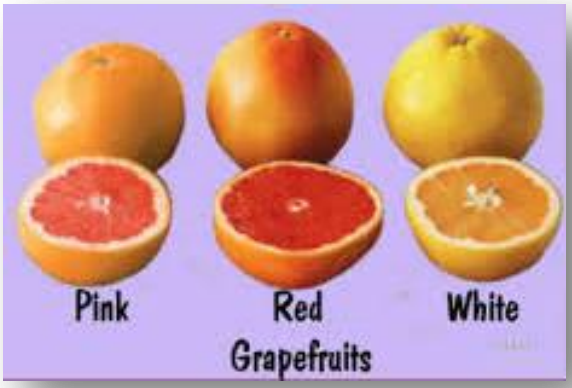
- ***Basic encyclopedia of grape fruit: -***

Grapefruit is a citrus fruit with a flavor that can range from bittersweet to sour. It contains a range of essential vitamins and minerals. People can consume the fruit whole or as a juice or pulp. It is a famous fruit; it was known as the shaddock or shattuck until the nineteenth century; its current name alludes; its botanical name is Citrus paradisi & is among Rutaceae; The general opinion is that grapefruit is a hybrid fruit that was formed by a cross between the orange *(Citrus sinensis***)** and Pomelo (*Citrus maxima*); it is a tree that produces a kind of old and monstrous lemon that can weigh up to 10 kg, with an average weight of about 4.5 kilograms.

- ***Grape fruit tree: -***


It is an evergreen tree of Rutaceae family up to 8 m high; it has erect stems and branches usually with spines; this evergreen grapefruit trees usually grow to around 5–6 meters (16–20 ft) tall, although they may reach 13–15 m (43–49 ft). The leaves are glossy, long and thin; it leaves are ovate, bright green, darker above, up to 15 cm long with a broadly winged petiole. It produces 5 cm white four-petaled flowers. Flowers appear solitary or in clusters, rather large. Grapefruit fruit is a hesperidium, 10 to 15 cm in diameter, sour, juicy, more rounded than orange with yellow skin, leathery, smooth and mottled. The flesh is segmented and acidic, varying in color depending on the cultivars, which include white, pink, and red pulps of varying sweetness. Although primitive varieties have many seeds, those which are sold today have few or almost none. The most common variety has a yellowish greenish pulp; other varieties can offer pink, red or white pulp, with different degrees of acidity and sweetness. Its cultivation requires a suitable climate, being the best a subtropical one with warm temperatures in order for the fruits to ripen faster (They take about 6 or 7 months). Adequate temperatures are also necessary so as fruits to have a thinner skin and a less acidic pulp. In not so warm places, fruits need more than a year to mature and develop thicker skins and a pulp with a higher level of acidity. They also prefer slightly acidic soil.

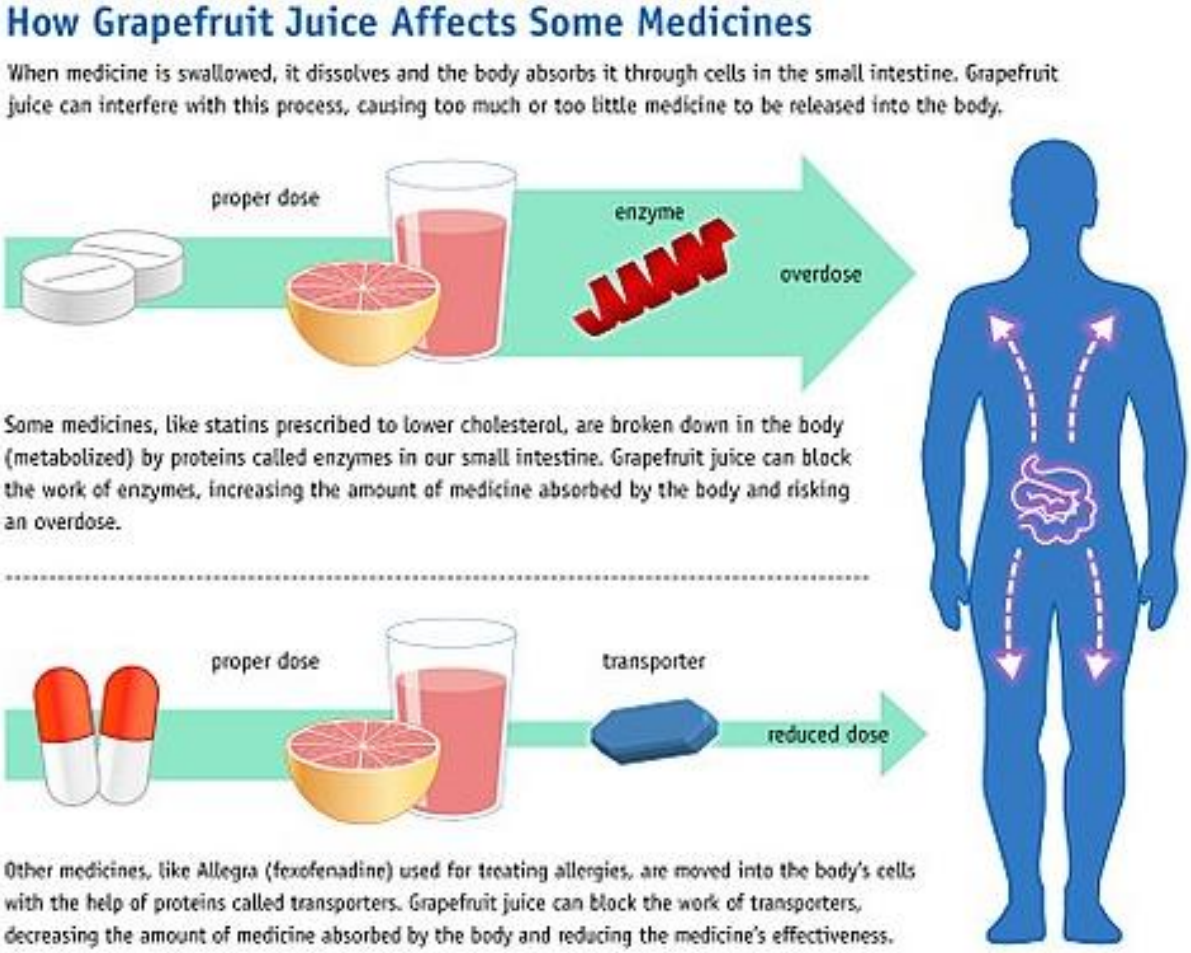
- ***Different types of grape fruits: -***



- ***pH of it is: -*** 2.9 to 3.3; it is acidic because its pH is below 7.
- ***Calories of grape fruit raw: -*** 100 grams of it gives 33 calories only. It contains 90% water, 8% carbs, very little fats & 1% protein.
- ***Glycemic index & Glycemic load of it: -*** Its glycemic index is 25 & glycemic load is only 3 from 120 grams; both are low & good for diabetes.
- ***Gross health benefits of it: -***

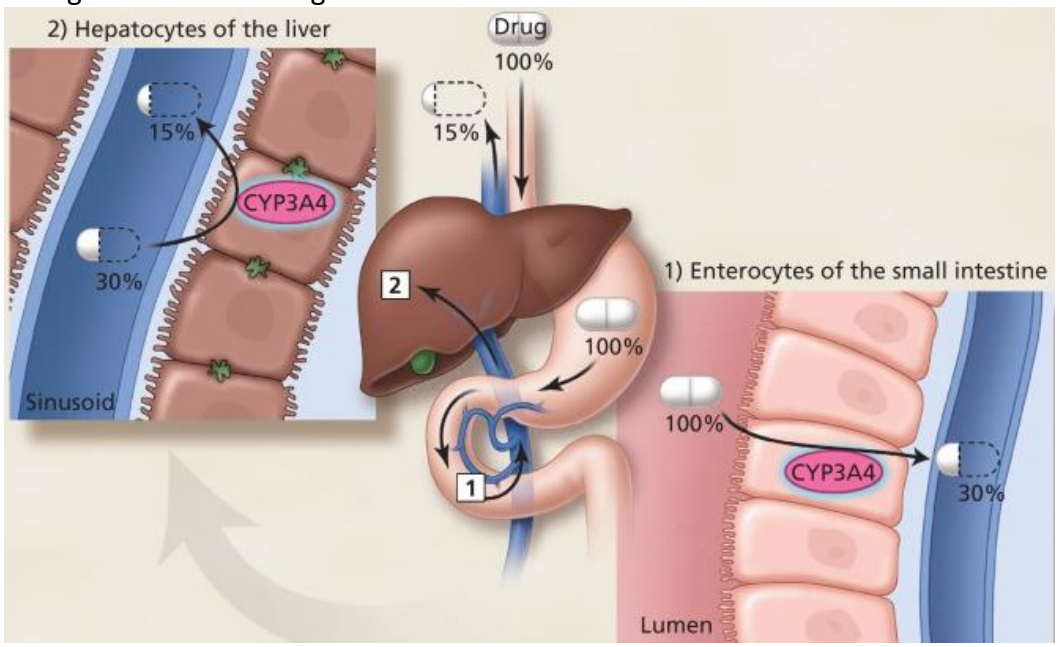
It's Low in Calories, Yet High in Nutrients; it may benefit our immune System; promotes appetite control; it is helpful in weight Loss; it helps in preventing insulin resistance and diabetes; eating it improves heart health; it is powerful antioxidants; reduce the risk of kidney stones, increases iron absorption thus helpful in anemia; it is a detox for our body, improves digestion & liver health; good for skin, nails etc.

- ***Clinical pharmacology of it: -***



The effect in most of the studies with grapefruit and grapefruit juice, but similar effects have been observed with certain other citrus fruits. One medical review advises patients to avoid taking medicines with all citrus juices until further research clarifies the risks. Fruit consumed three days before the medicine can still have an effect; it increases the absorption of many drugs & can result in drug toxicity or it reduces the absorption of many drugs leading to poor result of that medicine so it is advised not to use citrus fruit with medicine or during important drugs taken. The effects are caused by furanocoumarins (and, to a lesser extent, flavonoids; these chemicals inhibit key drug metabolizing enzymes, such as cytochrome P450 3A4 (CYP3A4). CYP3A4 is a metabolizing enzyme for almost 50% of drugs, and is found in the liver and small intestinal epithelial cells; as a result, many drugs are affected. Inhibition of enzymes can have two different effects, depending on whether the drug is either metabolized by the enzyme to an inactive metabolite, or activated by the enzyme to an active metabolite.

The active constituents of grapefruit & all citrus fruits are polyphenol compounds, including the flavonoid naringin and furanocoumarins (bergamottin, dihydroxybergamottin, bergapten, and bergaptol). It contains large amounts of naringin & it can take up to 72 hours before the effects of the naringin on the CYP3A4 enzyme are seen. 4-ounce (110 g) of grapefruit contains enough naringin to inhibit the metabolism of substrates of CYP3A4. Naringin is a flavonoid which contributes to the bitter flavour of grapefruit. For medications that interact due to inhibition of OATP (organic anion-transporting polypeptides), a relative short period of time is needed to avoid this interaction, and a 4-hour interval between grapefruit consumption and the medication should suffice. For drugs recently sold on the market, drugs have information pages (monographs) that provide information on any potential interaction between a medication and grapefruit juice. Because there is a growing number of medications that are known to interact with citrus, patients should consult a pharmacist or physician before consuming citrus while taking their medications.



Most of the benefits of it are due to vitamin C, citric acids, flavonoids, minerals, vitamins & chemical compound present in all citrus fruits also present in it.

Grapefruit seed extract: the grapefruit seed extract, a product with bacterial, fungal and anti-parasitic properties is widely used in natural medicine.

Grapefruit as fodder for livestock: In animal nutrition, grapefruit waste is converted into molasses, which are used as an ingredient for fodder. Grapefruit skins, once purified, can feed livestock.

- ***Modern uses of it: -***

Grapefruit as a raw fruit: it can be eaten directly, provided that they are sweetened with honey & little salt to neutralize its high degree of acidity.
Grapefruit juice: more common is consuming its flesh squeezed juice, especially enhanced for the so famous "lemon diet" for diuretic, re-mineralizing and slimming purposes.
Grapefruit vinegar, syrups or jams: Besides being eaten as a fruit or for its juice, many edible products are made from this fruit, such as grapefruit vinegar, syrups or jams.
Grapefruit seeds vegetable oil: We can obtain vegetable oil from grapefruit seeds. This must be refined to become high quality oil, very similar to olive oil and, highly recommended for human consumption.

- ***Contents/constituents of grape-fruit: -***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc. many of its compound & constituents are same as other citrus fruits.

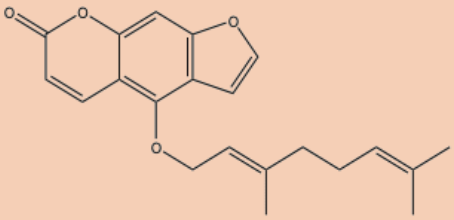
Principal Constituents of grape-fruit seed oil	**Constituent %**
α-Thujene :	0.54
β-Pinene :	0.25
Myrcene :	1.90
Octanal :	0.45
Limonene :	95.00
β-Ocimene :	0.08
γ-Terpinene :	0.15
Octanol :	Trace
Linalol :	0.13
Nonanal :	0.06
Citronellal :	Trace
Decanal :	0.27
Neral :	Trace
Geranial :	0.09
Geranyl acetate :	0.09
β-Caryophyllene :	0.24
Valencene :	0.06
Nootkatone :	0.10

Grapefruit, raw, white, all areas	
Nutritional value per 100 g (3.5 oz)	
Energy	138 kJ (33 kcal)
Water	90.48% (gram)
Carbohydrates	8.41 g
Sugars	7.31 g

Dietary fiber	1.1 g
Fat	0.10 g
Protein	.8 g
Vitamins	Quantity%DV[†]
Thiamine (B1)	3% 0.037 mg
Riboflavin (B2)	2% 0.020 mg
Niacin (B3)	2% 0.269 mg
Pantothenic acid (B5)	6% 0.283 mg
Vitamin B6	3% 0.043 mg
Folate (B9)	3% 10 µg
Choline	2% 7.7 mg
Vitamin C	40% 33.3 mg
Vitamin E	1% 0.13 mg
Minerals	Quantity % DV[†]
Calcium	1% 12 mg
Iron	0% 0.06 mg
Magnesium	3% 9 mg
Manganese	1% 0.013 mg
Phosphorus	1% 8 mg
Potassium	3% 148 mg
Zinc	1% 0.07 mg
Copper, cobalt, sodium, fluoride, iodine.	In minor quantity.
Other constituents	Quantity

- ***<u>Main chemical structures of grapes: -</u>***

INTERACTIONS WITH DRUGS

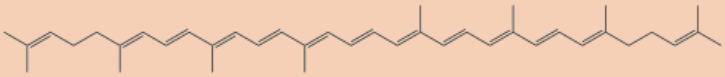


BERGAMOTTIN

Grapefruit, and grapefruit juice, is known to interact with a large number of drugs, usually resulting in adverse effects. These interactions are caused by a class of compounds called furanocoumarins, in particular the compounds bergamottin and dihydroxybergamottin.

These compounds inhibit some forms of an enzyme responsible for breaking down drugs in the body. As the prescribed dose of drugs takes into account how quickly the drug is broken down in the body, this can lead to higher concentrations of the drug in the bloodstream, which in turn can result in unpleasant side effects.

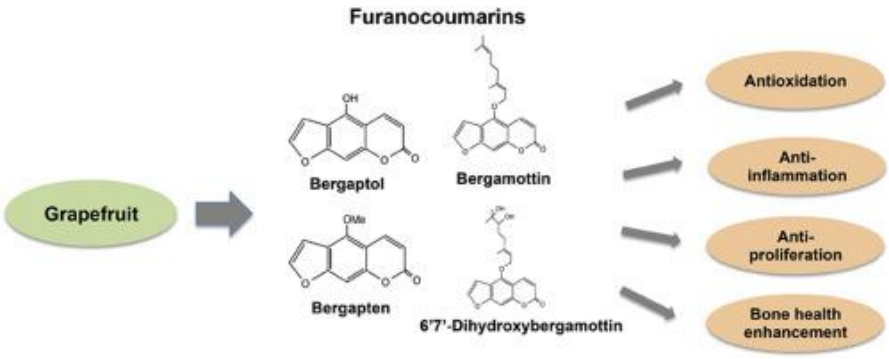
WHAT CAUSES A GRAPEFRUIT'S COLOUR?



LYCOPENE

The colour of pink and red grapefruits is caused by the compound lycopene. This is a compound composed entirely of carbon and hydrogen atoms. The compound absorbs all but the longest wavelengths of visible light, causing it to appear red.

Lycopene is also the compound responsible for the colouration of tomatoes. It is also used as a food colouring due to its strong colour and lack of toxicity.



Pomelo: -

The pomelo is also called as pummelo & botanically called as Citrus maxima or Citrus grandis; it is the largest citrus fruit from the family Rutaceae and the principal ancestor of the grapefruit. It is a natural (non-hybrid) citrus fruit, native to Southeast Asia and Malaysia. Similar in taste to a large grapefruit, the pomelo is commonly consumed and used for festive occasions throughout Southeast Asia. It is also famous like other citrus fruit & eaten worldwide; it is of many types some very big some medium size depending on different region, climate, soil & harvesting methods.

- ***Encyclopedia of Pomelo tree: -***


The pomelo tree may be 16–50 feet (4.9–15.2 m) tall, possibly with a crooked trunk 4–12 inches (10–30 cm) thick, and low-hanging, irregular branches. Leaf petioles are Petioles are broadly winged distinctly winged, with alternate, ovate or elliptic shapes 2–8 inches (51–203 mm) long, with a leathery, dull green upper finish, and hairy lower leaf. The leaves are frequently emarginated, Pubescent beneath, acute apex, asymmetric base, entire margin, characteristic odour. The flowers are large single or in clusters; has pleasant fragrant and are yellow-white in color & have white stamens 16-24 in number. The pomelo is a large citrus fruit, 15–25 centimeters (6–10 in) in diameter, usually weighing 1–2 kilograms (2–4 lb). It has a thicker rind than a grapefruit. It has 11–18 segments, the flesh tastes like a mild grapefruit (believed to be a hybrid of Citrus maxima and the orange). The flesh has little of the common grapefruit bitterness. The enveloping membranous material around the segments is bitter, considered inedible, and usually discarded. There are two varieties: a sweet kind with white flesh, and a sour kind with pinkish flesh, the latter more likely to be used as a ceremony, rather than eaten. The fruit generally contains few large seeds, but some varieties have numerous seeds.

The seeds of the pomelo are monoembryonic (monoembryony is the emergence of one and only one seedling from a seed. A seed giving two or more seedlings is polyembryonic), producing seedlings identical to their parents, and therefore pomelo is typically grown from seed. Seeds can be stored for 80 days at 41 °F (5 °C) and with moderate relative humidity. High-quality varieties are propagated by air-layering or by budding onto favored rootstocks. Also it is usually grafted onto other citrus rootstocks.

The pomelo is one of the original citrus species from which the rest of cultivated citrus have been hybridized. Raw pomelo flesh has 89% water, 10% carbohydrates, 1% protein, and contains negligible fat. A 100 gram provides 38 calories, and is rich in vitamin C & many important compounds, vitamin & minerals. Pomelo may cause adverse effects, similar to those caused by grapefruit, through the inhibition of cytochrome-P450-mediated metabolism of prescription drugs such as anti-hypertensive and anticoagulants. Detail is given in clinical pharmacology subtitle below.




- ***pH of pomelo is it: -*** 3.8; it is acidic because its pH is below 7.
- ***Calories of pomelo is it: -*** 100 grams of raw fruit givens 38 calories.
- ***Glycemic index & Glycemic load: -*** glycemic index to be between 72 and 78 and the glycemic load to be around 4 to 5. Its glycemic index is high so diabetic patient should eat it less & glycemic loads is low.
- ***Gross health benefits of pomelo: -***

It is highly nutritious & contains a variety of vitamins and minerals and is an excellent source of vitamin C; full of fiber one pomelo offers 6 grams of fiber; May promote weight loss; Rich in antioxidants; boost heart health; have anti-aging properties; it is antibacterial and antifungal; fight cancer cells; promotes nail, hair & skin health, increase complexion, helpful in lung disease, digestive diseases, promotes bone & overall health etc; eat it with precaution when you are taking some medicines detail given in clinical pharmacology section below.

- ***Clinical pharmacology of pomelo: -***

A study revealed that oral administration of pomelo juice twice daily for 7 days significantly increased plasma concentrations of simvastatin and simvastatin acid in rats. We found that pomelo juice significantly inhibited rat hepatic CYP3a2 activity and suppressed hepatic Slc21a5 gene expression. Additional, down-regulations of Mdr1a and Mdr1b gene expression were detected in rat intestines following pomelo juice administration. Taken together, it is likely that changes in activity of CYP3a2, a key drug-metabolizing enzyme, and expression of Mdr1a, Mdr1b, and Slc21a5, important drug transporters, lead to altered pharmacokinetic profiles of simvastatin and simvastatin acid and may be extrapolated to other drugs that are substrates of the enzyme and transporters. Given the potential interaction between pomelo juice and simvastatin, it seems reasonable to conclude that simvastatin-treated patients should be advised to avoid such interaction.

Naringenin is the most abundant flavanone present in pomelo & other citrus fruits; naringenin has been recently reported to possess anti-inflammatory effects by inhibiting leukocyte recruitment and reducing oxidative stress, boost antioxidant capacity by activating Nrf2 which induces HO-1 expression, and suppress activation of NF-κB in macrophages which causes the production of pro-inflammatory

cytokines such as IL-33, TNF-α, IL-1β, and IL-6. Also naringenin inhibits NF-κB signaling pathway by decreasing translocation and DNA binding of NF-κB. It can inhibit the production of TNF-α and various pro-inflammatory interleukins and decrease nuclear translocation and DNA binding of AP-1 by blocking phosphorylation of MAPKs. Naringenin, therefore, appears to exert anti-inflammatory effects through several molecular signaling pathways by relieving oxidative stress in both in vivo and in vitro studies. In the liver, naringenin attenuates CCl4-induced hepatic inflammation by the activation of a Nrf2-mediated pathway in rats.

Citrus maxima are a perennial shrub commonly known as Papanus, distributed throughout India. Bark and root of Citrus maxima contain β-sitosterol, acridone alkaloid. Essential oil from the leaves and unripe fruits contain limonin, nerolol, nerolyl acetate and geraniol [6]. Like other citrus plant pommelos are rich in Vitamin C. They are generally used eaten as fruit. It has been used in indigenous system of medicine as sedative in nervous affections, convulsive cough and in the treatment of hemorrhagic diseases and epilepsy. It is said to poses appetizing, cardiac stimulant and antitoxic property [7] . Citrus maxima fruits also contains high amount of polyphenolic compound like hesperidin, naringin, caffeic acid, P-Coumaric acid, Ferulic acid and vanillic acid [6]. It shows various pharmacological activities which has been studied. In this work the review has been made on the reports of various studies on the plant Citrus maxima. Its traditional uses are 1) Leaves: Epilepsy, chorea, Convulsive cough and also in the treatment of hemorrhage disease. 2) Oil from fresh leaves posses anti dermatophytic activity, Fungicidal activity. 3) Flower: Used as sedative in nervous affection Fruits: Leprosy, Asthma, Cough, hiccough, mental aberration, Epilepsy, cardio-tonic. 4) Rind: Anti-asthmatic, sedative in nervous affection, Brain tonic, Useful in vomiting, griping of abdomen, diarrhea, Headache and eye troubles. 5) Root and Bark: Antimicrobial activity.

Ethanolic, acetone and aqueous extracts were obtained by soaking the leaves, stem bark and fruit peel of citrus maxima for 72 hrs. These extracts were evaluated for the analgesic activity in Acetic acid induced writhing in mice; Ethanolic extract of stem bark of citrus maxima was obtained by continuous hot peculation method. Acute toxicity studies were done as per the OECD-425 Guidelines. Anti diabetic activity was studied in the Alloxan induced anti diabetic activity, Streptozotocin induced anti diabetic activity and Oral glucose tolerance test.

- ***Modern uses of it: -***

To maintain general health: -

Take few pieces of pomelo cut in small piece put it in mixer jar, add 1 or 3 dates, half cucumber, halt beetroot, 1 spoon honey, 7 seeds of black caraway & fenugreek, 1 cup water mix all in mixer & prepare a juice drink it once or twice a week.

For heart health: -

Take few pieces of pomelo cut in small piece put it in mixer jar, add 1 clove garlic, small piece of ginger, half beetroot, 1 spoon honey, 5 small pieces of watermelon add 1 cup water & mix all in mixer & prepare a juice & drink it once or twice a week.

- ***Active components of it: -*** naringin, hesperidin, neohesperidin and naringenin.
- ***Contents/constituents of it: -***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc.

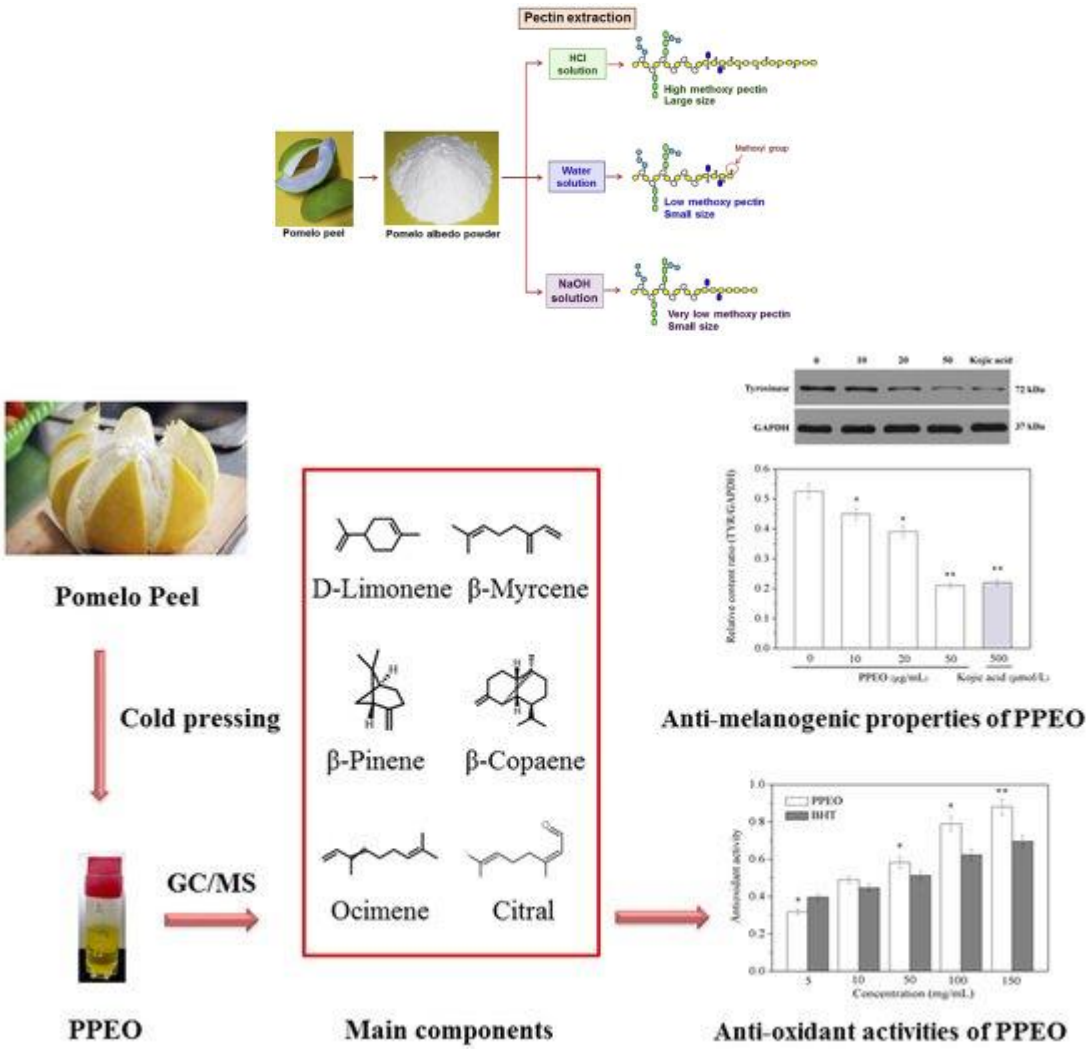
It contents: Alkaloids: 5-hydroxyacronycine, acriginine A, Atalafoline, Baiyumine A &B, Buntanine, Buntanmine, Grandisine I & II, Pumiline, honyumine, natsucrin, Prenyl citpressine, Citropone A & B, Glycocitrine I are present in the roots and the bark of the plant. Whereas the caffeine is present in the flowers of the Citrus maxima.

Amino Acids: Alanine, Asparigine, Aspartic acid, Coline, Glutamic acid, Glycine And proline are present in the leaves. Carbohydrates: Phytol, Synephrine, Methyl antralinate, Fructose, Glucose and Pectin are present in the Leaf, peel and flowers; Carotenoids: Carotene and Roseoside present in the peels. Coumarins: 5-Geranoxy-7-methoxy-Coumarin, Aurapte, Auraptene, bergamottin are present in the peels and 5-methoxy seselin, 5-methyltodannol, 6-hydroxy methylherniarin are present in the roots and stem bark. Flavonoids: acacetin, rutin,

tangeretin, cosmosiin, diosmetin, diosmin, eriocitrin, hespeidin, naringin. Monoterpenes: α-pinene, α-terpineol, anethole, β-pinene, Camphene, camphor, citral, citronellal, citroonellol, farnesol, geraniol, myrcene, neral, terpinene. Sesquiterpenes: α-Bisabolol, α-cadinene, α-copaene, elemol. Steroids: β-Sitosterol, Campesterol, daucosterol, stigmasterol. Miscellaneous: α- tocopherol, ascorbic acid, chlorophylls, decyl acetate, Malonic acid, Fumaric acid, succinic acid and Citric acid.

Flesh of a pomelo	
Nutritional value per 100 g (3.5 oz)	
Energy	159 kJ (38 kcal)
Carbohydrates	9.62 g
Dietary fiber	1 g
Fat	0.04 g
Protein	0.76 g
Vitamins	**Quantity%DV**[†]
Thiamine (B1)	3% 0.034 mg
Riboflavin (B2)	2% 0.027 mg
Niacin (B3)	1% 0.22 mg
Vitamin B6	3% 0.036 mg
Vitamin C	73% 61 mg
Minerals	**Quantity%DV**[†]
Iron	1% 0.11 mg
Magnesium	2% 6 mg
Manganese	1% 0.017 mg
Phosphorus	2% 17 mg
Potassium	5% 216 mg
Sodium	0% 1 mg
Zinc	1% 0.08 mg
Other constituents	**Quantity**
Water	89 g

- ***Main chemiocal structures of pomelo: -***


Pectin extraction
HCl solution
High methoxy pectin
Large size
Water solution
Low methoxy pectin
Small size
NaOH solution
Very low methoxy pectin
Small size
Pomelo peel
Pomelo albedo powder
Pomelo Peel
Cold pressing
GC/MS
PPEO
D-Limonene
β-Myrcene
β-Pinene
β-Copaene
Ocimene
Citral
Main components
Anti-melanogenic properties of PPEO
Anti-oxidant activities of PPEO
PPEO
BHT

Citron: -

e

Citron is like big size lemon; it is of various types, size & taste depending on different regions; it is not very common & not available at all places all season; its botanical name is Citrus medica belongs to Rutaceae family.

- ***Encyclopedia of citron: -***

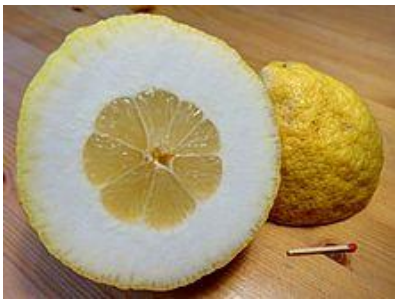
The citron (*Citrus medica*) is a large fragrant citrus fruit with a thick rind. It is one of the three original citrus fruits from which all other citrus types developed through natural hybrid speciation or artificial hybridization. Though citron cultivars take on a wide variety of physical forms, they are all closely related genetically. It is used widely in Asian cuisine, and also in traditional medicines, perfume, and for religious rituals and offerings. Hybrids of citrons with other citrus are commercially prominent, notably lemons and many limes. The citron is usually fertilized by self-pollination. The citron is thought to have been native to India (mainly from eastern Himalaya).

- ***Citron tree: -***

Citrus medica is a slow-growing shrub or small tree that reaches a height of about 8 to 15 ft (2 to 5 m). It has irregular straggling branches and stiff twigs and long spines at the leaf axils. The evergreen leaves are green and lemon-scented with slightly serrate edges, ovate-lanceolate or ovate elliptic 2.5 to

7.0 inches long. Petioles are usually wingless or with minor wings. The clustered flowers of the acidic varieties are purplish tinted from outside, but the sweet ones are white-yellowish. The citron tree is very vigorous with almost no dormancy, blooming several times a year, and is therefore fragile and extremely sensitive to frost. The tree can grow to a size of about 3 meters. The citron tree is slow-growing. The citron tree is typically grown from cuttings that are two to four years old; the tree begins to bear fruit when it is around three years old.

- ***Citron fruit: -***

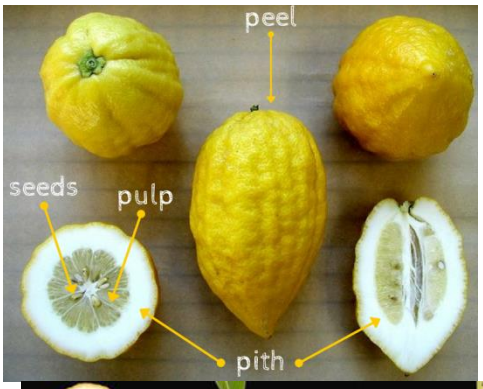

The citron fruit is usually ovate or oblong, narrowing towards the stylar end. However, the citron's fruit shape is highly variable, due to the large quantity of albedo, which forms independently according to the fruits' position on the tree, twig orientation, and many other factors. The rind is leathery, furrowed, and adherent. The inner portion is thick, white and hard; the outer is uniformly thin and very fragrant. The pulp is usually acidic, but also can be sweet, and some varieties are entirely pulp-less. The fruit can grow to a size of about 25 cm in length.

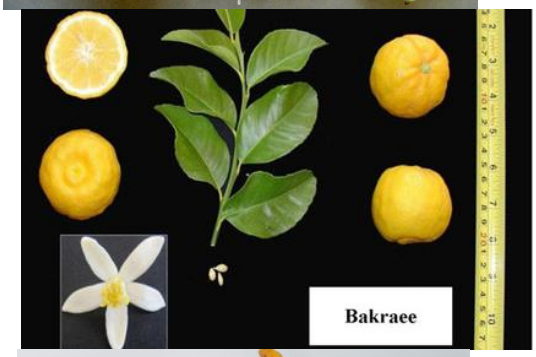
Most citron varieties contain a large number of monoembryonic seeds. The seeds are white with dark inner-coats and acidic varieties have red-purplish spots. Some citron varieties have persistent styles which do not fall off after fecundation. Those are usually preferred for ritual *etrog* use.

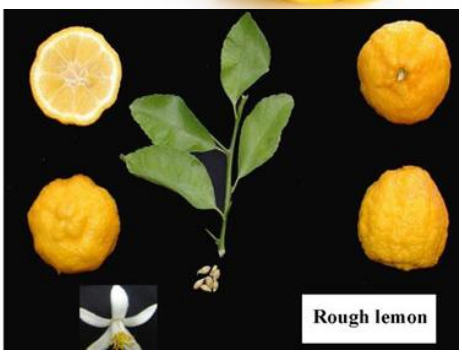
Some citrons have medium-sized oil bubbles at the outer surface, medially distant to each other. Some varieties are ribbed and faintly warted on the outer surface. A fingered citron variety is commonly called Buddha's hand.

The color varies from green, when unripe, to a yellow-orange when overripe. The citron does not fall off the tree and can reach 8–10 pounds (4–5 kg) if not picked before fully mature. However, they should be picked before the winter, as the branches might bend or break to the ground, and may cause numerous fungal diseases for the tree.

Despite the wide variety of forms taken on by the fruit, citrons are all closely related genetically, representing a single species. Genetic analysis divides the known cultivars into three clusters: a Mediterranean cluster thought to have originated in India, and two clusters predominantly found in China, one representing the fingered citrons, and another consisting of non-fingered varieties. For many centuries, citron's fragrant essential oil has been used in perfumery, the same oil that was used medicinally for its antibiotic properties. Its major constituent is limonene. In South Indian cuisine, especially Tamil cuisine, citron is widely used in pickles and preserves. In Tamil, the unripe fruit is referred to as 'narthangai', which is usually salted and dried to make a preserve. The tender leaves of the plant are often used in conjunction with chili powder and other spices to make a powder, called 'narthellai podi', literally translating to 'powder of citron leaves'. Both narthangai and narthellai podi are usually consumed with 'thayir sadam'. Citron trees are grown readily from cuttings taken from branches 2 to 4 years old and quickly buried deeply in soil without defoliation. The citron tree blooms nearly all year, but mostly in spring and the spring blooms produce the major part of the crop. The fruit is dark-green when young, takes 3 months to turn yellow. The citron does not fall off the tree and can reach 8–10 pounds (4–5 kg) if not picked before fully mature. However, they should be picked before the winter, as the branches might bend or break to the ground, and may cause numerous fungal diseases for the tree.








- ***pH of citron juice: -*** between 3 to 4 more or less it depends on the type & region; it is acidic.
- ***Calories of citron juice: -*** 100 grams juice gives 40 calories more or less.
- ***Glycemic index & glycemic load of citron juice: -*** GI & GL both are low means can be eaten by diabetic patient but not in excessive quantity.
- ***Gross benefits of citron: -***

From ancient through medieval times, the citron was used mainly for medical purposes: to combat seasickness, pulmonary troubles, intestinal ailments, scurvy and other disorders. The essential oil of the flavedo (the outermost, pigmented layer of rind) was also regarded as an antibiotic. Citron juice with wine was considered an effective antidote to poison, as Theophrastus reported. In the Ayurvedic system of medicine, the juice is still used for treating conditions like nausea, vomiting, and excessive thirst.

The juice of the citron has a high Vitamin C content and is used in the Indian system of medicine as an anti-helmintic, appetizer, tonic, rheumatism, vomiting, flatulence, haemorrhoids (piles), skin diseases and weak eyesight. There is an increasing market for the citron for the soluble fiber (pectin) found in its thick albedo. It is anti-inflammatory, antioxidant, helpful in asthma, anticancer, improves digestion, increases strength, immunity, liver function, increases appetite, reduces cough, phlegm, maintains skin, hair & nails health etc.

- ***Modern uses of it: -***

Make pickle of it using apple cedar vinegar, small piece of citron, little garlic, ginger, honey, turmeric etc this is like medicine to you &eat it with meals in little quantity twice a week all season mainly in winter to keep yourself free from diseases, cold & cough, lungs infection, digestive infection, indigestion, heart health etc.

- ***Clinical pharmacology: -***

Peel of it is characterized by the presence of monoterpenes and sesquiterpenes showed significant antioxidant activity; it is considered as the main anti-cancer foods, because of their abundant antioxidants such as phenols, vitamin C, vitamin E, beta-carotene and lipotene. The petroleum ether extract of C. medica. Seeds (200 and 400 mg/kg) induced significant reduction ($p < 0.05$) of fasting blood glucose, serum cholesterol, serum triglycerides, LDL and VLDL in dose dependent manner after 15 days of drug administration. Aqueous extract of the fruits of C. medica showed statistically significant decrease in the ulcer scores, % of ulcers and ulcer index against ethanol-induced ulcers in rats.

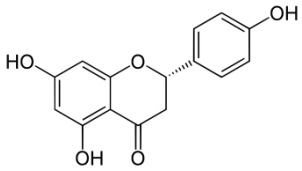
- ***Contents/constituents of it: -***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc. Many constituents of citron are same as other citrus fruits.

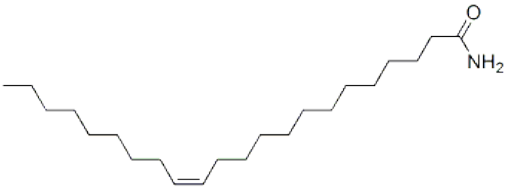
- ***Active components of it: -*** is mainly naringenin.

Erucylamide, limonene, citral, mehp, octadein, cyclohexanediol, methoprene, isoliminene, B-myrcene, nerylacetate, neryl-alcohol & many constituents are same as other citrus fruit lemon.

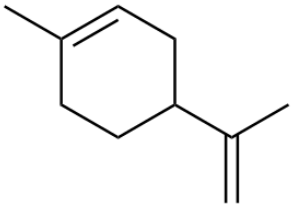
- ***Main chemical structures of citron: -***



Naringenin

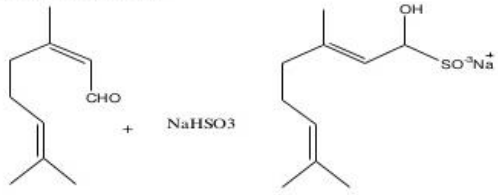


erucylamide

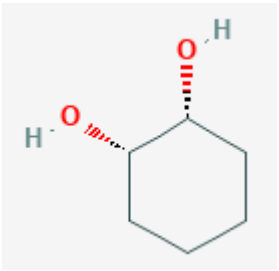


Limonene

Citral form both mono and di bisulfite by the addition of sodium bisulfite to reveal the presence of conjugated aldehyde group its UV spectrum displayed a band at 238 nm to confirm this.

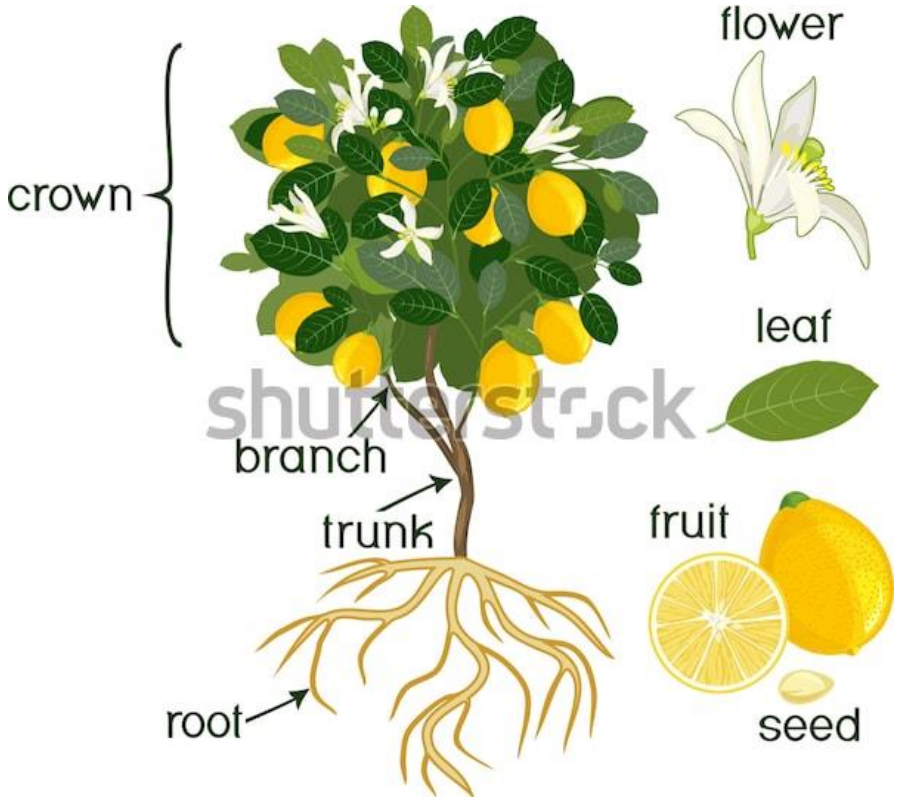


citral



cyclohexanediol

Limes: -



Lime fruits are very famous & eaten common worldwide, easy available, cheap, they are sweet & beneficial for health; it is of many types depending on different region, sol, climate, cultivation, harvesting etc. There are several species of citrus trees whose fruits are called limes, including the Key lime (*Citrus aurantiifolia*), Persian lime, kaffir lime, and desert lime. Limes are a rich source of vitamin C, are sour, and are often used to accent the flavours of foods and beverages. They are grown year-round. Plants with fruit called "limes" have diverse genetic origins; limes do not form a monophyletic group. The difficulty in identifying exactly which species of fruit are called lime in different parts of the English-speaking world (and the same problem applies to homonyms in other European languages) is increased by the botanical complexity of the citrus genus itself, to which the majority of limes belong. Species of this genus hybridise readily, and it is only recently that genetic studies have started to throw light on the structure of the genus. The majority of cultivated species are in reality hybrids, produced from the citron (*Citrus medica*), the mandarin orange (*Citrus reticulata*), pomelo (*Citrus maxima*) and in particular with many lime varieties, the micrantha (*Citrus micrantha*). The botanical name of Persian lime is *Citrus latifolia, it* is one of the most common commercial varieties, though the smaller key lime, or Mexican lime's botanical name is *Citrus aurantiifolia* it is also economically important in many places & belongs to Rutaceae. And Sweet limes botanical name *Citrus limettioides*; large fruited acid limes *Citrus latifolia.* Kaffir lime botanical name is *Citrus hystrix*; Bearss limes botanical name is *Citrus latifolia*.



- ***Encyclopedia of Lime tree: -***

The *Citrus* genus is a group of flowering plants in the family Rutaceae (orange family) that originated in tropical and subtropical south-east Asia and that have a distinctive berry with the internal parts divided

into segments. The tree seldom grows more than 5 meters (16 feet) high and if not pruned becomes like shrub. Its branches spread and are irregular, with short stiff twigs, small leaves, and many small sharp thorns. The evergreen leaves are pale green, and the small white flowers are usually borne in clusters. The fruit is usually oval to nearly globular in shape, often with a small apical nipple, and the peel is thin and greenish yellow when the fruit is ripe. The pulp is tender, juicy, yellowish green in colour, and decidedly acid. Limes exceed lemons in both acid and sugar content; however, some varieties so lacking in citric acid that they are known as sweet limes. It is small, densely and irregularly branched, evergreen tree, about 5 m tall; twigs armed with short, stiff, sharp spines. Leaves alternate, elliptic to oblong-ovate, 4-8 x 2-5 cm, margin crenulate; petioles narrowly winged. Inflorescences short axillary racemes; flowers are small, white in bud; calyx cup-shaped, 4- to 6-lobed; petals 4-6, 8-12 mm long; stamens, ovary 9-12 celled, style abruptly distinct. Flowers are either perfect or male and borne in inflorescences of up to 10 flowers in the leaf axils of mature shoots, but are often single in the axils of a shoot which has just flushed. The stigma is receptive as the flower opens and remains so for a few days. Pollen is not released until the flower has opened. Copious secretion of nectar by a floral disk attracts insects, especially honeybees, which pollinate the flowers. Self-pollination occurs, but self-incompatibility limits fruit set. Fruit requires 5.5-6 months from flowering to harvest. Fruit a globose to ovoid berry, 3-6 cm in diameter, sometimes with apical papillae, greenish-yellow; peel very thin, very densely glandular; segments with yellow-green pulp-vesicles, very acid, juicy and fragrant. Seeds are small, plump, ovoid, pale, smooth with white embryos (polyembryonic). Lime is believed to have originated in northern India and adjoining parts of Myanmar, or in northern Malaysia. The lime is now cultivated throughout the tropics and in warm subtropical areas.

The sour limes were probably one of the first citrus fruits to be carried from the east by the crusaders. Arabs carried the sour lime to North Africa and surrounding regions. It was then transported from Palestine to Mediterranean Europe. By the mid-13th century the small-fruited acid lime was well known in Italy and France. Spanish and Portuguese explorers probably transported this cultivar to the Americas during the 16th century. It was naturalized throughout the Caribbean, Eastern Mexico, tropical South America, Central America and the Florida.

- ***Different types of limes: -***

Australian desert lime

Australian desert lime is botanically called as Citrus glauca, this is one of the smallest limes.


Australian blood lime

Australian Blood lime is hybrids that were developed in Australia. The fruit is blood-red in color, and it is much smaller than other types of limes.


Ginger lime also called Ada jamir lime.

Ginger Lime have smooth skin and firm, yellow flesh, ginger limes have about a dozen seeds in them and a thick rind.


Kaffir lime

Kaffir lime are bumpy and round, and there is very little bitter taste juice in it.


Kalamansi lime also called calamansi lime

Kalamansi lime also known as Calamondin or Musk limes are very tart and used in a lot of Philippine cuisine.

key lime & common lime difference

Key lime also called Mexican limes, these limes are rounder, smaller, and more yellow in color


Kusaie lime

Kusaie lime are thought to be a form of the Mandarin lime and likely originated in India. It is an oval or round shaped lime with a base that is faintly necked and a nipple that is slightly pointed.


Limequats

Limequat is a cross between limes and kumquats. They are small and round, with a yellowish color and a very acidic flavor.


Limeeta lime

Limetta lime (Palestinian Sweet Lime) is thought to be a hybrid between a sweet lemon and a Mexican lime and believed to be native to India.


Mandarain lime

Mandarin Lime These limes are actually a group of three very similar limes. They include the Rangpur lime, the Kusaie lime, and the Otaheite lime.


omani lime

Omani Lime are very small but have a strong aroma and a strong flavor. Originating in the Middle Eastern country of Oman


Rangpur lime

Rangpur Lime these types of limes are very tart and acidic, but also very juicy. They also do not look like limes, but rather, they resemble tangerines or oranges.

- ***pH of lime juice is;*** 2.8 or more depends on type of lime; it is acidic because its pH is less 7.
- ***Calories of lime: -*** 100 ml juice gives 25 calories & raw 100 mg lime fruit gives 30 calories.
- ***Glycemic index & Glycemic load of it: -*** Glycemic index is 24 & glycemic load is 1 only both are low & good for diabetic patients means diabetes patients can eat it but little quantity.
- ***Gross health benefits of it: -***

It is antioxidant, anti-inflammatory, anti viral, anti bacterial, anti fungal, anti-lipid, helps in controlling blood pressure, good for lungs diseases, digestive diseases, tuberculosis, best for quick recovery, helpful in malaria, dengue, typhoid recovery, it prevents kidney stone, increases iron absorption, promotes skin, nail & hair health, prevents heart disease, increases immunity, helpful in diabetes, control weight, anti cancer, heals peptic ulcers; all types of lime are good for health but the more juice the best etc.

- ***Clinical pharmacology of it : -***

Secondary metabolites of lime are alkaloids, carotenoids, coumarins, essential oils, flavonoids, phenolic acids, and triterpenoids. The other important & active constituents of lime are apigenin, hesperetin, kaempferol, limonoids, quercetin, naringenin, nobiletin, and rutin, all of these contribute to its remedial

properties. In addition, Lota *et al*. reported at least 62 volatile compounds in the fruit peel oils and 59 in the leaf oils of several lime species. In the fruit peel oils, limonene was the major volatile component, followed by terpinene, pinene, and sabinene. For leaf oils, limonene, pinene, and sabinene were the major components, followed by citronellal, geranial, linalool, and neral. Patil *et al*. reported that *C. aurantifolia* fruit from Texas, USA, consists of at least 22 volatile compounds, and its major compounds were limonene (30%) and dihydrocarvone (31%). About 100 µg/ml of *C. aurantifolia* extract can inhibit the growth of colon SW-480 cancer cell. Patil *et al*. found the new three coumarins from *C. aurantifolia* peel from Texas that were 5-geranyloxy-7-methoxycoumarin, limettin, and isopimpinellin. About 25 µM of *C. aurantifolia* extract can inhibit the growth of colon SW-480 cancer cell. Patil *et al*. reported that the active components of *C. aurantifolia* juice contain rutin, neohesperidin, hesperidin, and hesperetin. They also found limonoid substances such as limonexic acid, isolimonexic acid, and limonin. Moreover, 100 µg/ml of *C. aurantifolia* juice extract can stop 73–89% of pancreatic Panc-28 cancer cells growth after 96 h of exposure. Gharagozloo *et al*. reported that the 125–500 µg/ml of *C. aurantifolia* fruit juice extract from Iran inhibits the growth of breast MDA-MB-453 cancer cell after 24 h of exposure. Castillo-Herrera *et al*. reported that the limonin extract from *C. aurantifolia* seed from Mexico inhibits the growth of L5178Y lymphoma cells with IC_{50} of 8.5–9.0 µg/ml.

- ***Modern uses of it: -***

For any type of cancer, flu illness, for quick recovery etc: -

Take half glass of fresh lime juice, half glass water, take 1 spoon of honey, 7 seeds of crushed black caraway & fenugreek, 1 teaspoon on extra virgin olive oil eat it all together or prepare a juice out of all & consume it early morning empty stomach for 11 days followed by one or twice a week.

For preventing diseases: -

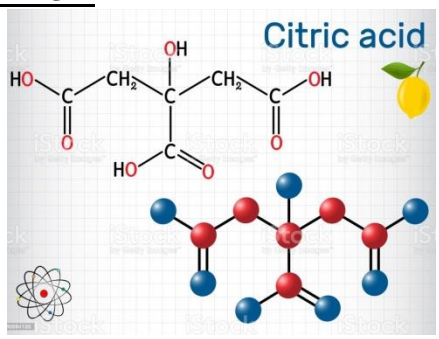
Eat 1 lime a week on empty stomach with 1 spoon of honey & 3 dates till 21 weeks.

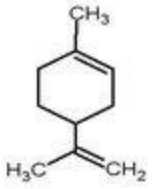
- ***Contents/constituents of it: -***

All contents may not present in all types of it, because there are many varieties of it according to geographical regions & content may differ a lot as per cultivation, soil, seed, climate etc.

The bioactive compounds from citrus in many countries were reported, for example, Italy: Spadaro *et al*. reported the fruit essential oils of *C. aurantifolia* as limonene (59%), β-pinene (16%), γ-terpinene (9%), and citral (5%). In the same research group, Costa *et al*. reported the fruit essential oils of *C. aurantifolia* as limonene (54%), γ-terpinene (17%), β-pinene (13%), terpinolene (1%), α-terpineol (0.5%), and citral (3%). Nigeria: Okwu and Emenike determined the phytochemical and vitamin contents of five varieties of citrus species; *C. sinensis*, *C. reticulata*, *C. limonum*, *C. aurantifolia*, and *C. grandis*. The presence of bioactive compounds in 100 g of citrus comprise alkaloids (0.4 mg), flavonoids (0.6 mg), phenols (0.4 mg), tannins (0.04 mg), ascorbic acids (62 mg), riboflavin (0.1 mg), thiamin (0.2 mg), and niacin (0.5 mg). Further, the same researchers' group including Okwu and Emenike also reported that these citrus fruits contains crude protein (18%), crude fiber (8%), carbohydrate (78%), moisture (6%), crude lipid (1%), ash (8%), and food energy content was (363 g/cal) of fresh fruits. The most important minerals detected in the fruit include calcium (3%), phosphorus (0.4%), potassium (1%), magnesium (0.6%), and sodium (0.4%). Lawal *et al*. reported that the leave essential oil of *C. aurantifolia* contains limonene (45%) and geranial (38%). Taiwan: Wang *et al*. reported that the chemical substances from citrus fruit contain hesperidin, the major flavanone (6 mg/g), naringin (2 mg/g), diosmin, the major flavone (0.7 mg/g), kaempferol, the major flavanol (1 mg/g), chlorogenic acid, the major phenolic acid (0.1 mg/g), β-cryptoxanthin, the major carotenoid (7 µg/g), and β-carotene (4 µg/g), followed by total pectin (87 mg/g). Mexico: Sandoval-Montemayor *et al*. reported that *C. aurantifolia* fruit peels consist of 44 volatile compounds, for example, dimethoxycoumarin (16%), cyclopentanedione (9%), methoxycyclohexane (8%), corylone (7%), palmitic acid (7%), dimethoxypsoralen (6%), α-terpineol (6%), and umbelliferone (5%).

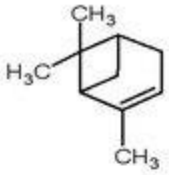
- ***Main chemical structures of lime: -***



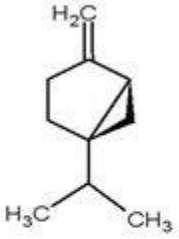


Limonene

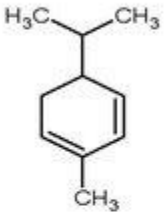
α– pinene



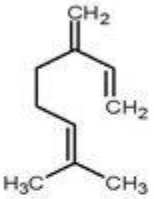
β– pinene



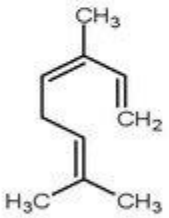
Sabinene



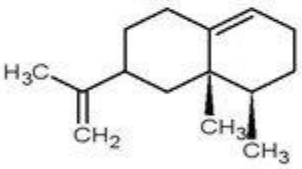
α– phellandrene



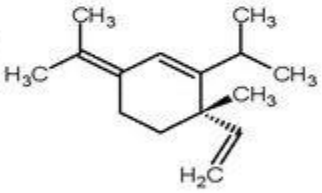
β– myrcene



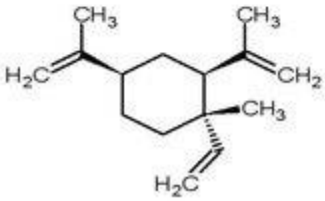
Ocimene



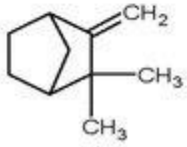
Valencene



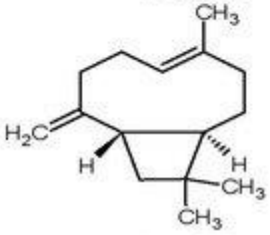
α- elemene



β– elemene



Camphene



Caryophylene

Nutrition of limes, raw	
 Limes, whole and in cross section	
Nutritional value per 100 g (3.5 oz) gives 30 calories.	
Energy	126 kJ (30 kcal)

Carbohydrates	10.5 g
Sugars	1.7 g
Dietary fiber	2.8 g
Fat	0.2 g
Protein	0.7 g
Vitamins	Quantity % DV†
Thiamine (B1)	3% 0.03 mg
Riboflavin (B2)	2% 0.02 mg
Niacin (B3)	1% 0.2 mg
Pantothenic acid (B5)	4% 0.217 mg
Vitamin B6	4% 0.046 mg
Folate (B9)	2% 8 µg
Vitamin C	35% 29.1 mg
Minerals	Quantity % DV†
Calcium	3% 33 mg
Iron	5% 0.6 mg
Magnesium	2% 6 mg
Phosphorus	3% 18 mg
Potassium	2% 102 mg
Sodium	0% 2 mg
Other constituents	Quantity
Water	88.3 g

- ***Natural Basic Pharmacology of constituents of all citrus fruits explained separately based on human intake in natural food products: -***

The details given below are based on natural ingredients.

- ***Linalool: -***

It refers to 2 enantiomers (opposite or mirror image) of naturally occurring mono-terpene found in flowers & plants of many spices; it has a role plant metabolite, a volatile oil component, an anti microbial agent, a fragrance agent, it is present in sweet basil, lavender, laurel, citrus fruits, cinnamon, rosewood, birch tree, tea tree oil etc. It is anti anxiety, anti depressant, sedative, anti inflammatory, anti epileptic, increase immunity. It is under research & its absorption, metabolism is not known.

- ***Synephrine: -***

Synephrine, or, more specifically, *p*-synephrine, is an alkaloid, occurring naturally in some plants and animals, it is present in the leaves, peel, juice, fruit of various *Citrus* trees, it is a sympathomimetic agent

with vasoconstrictor and bronchiectatic activities that is a constituent of peel of citrus fruit, e.g., Bitter or Seville orange (Citrus aurantium L). As a pharmaceutical, m-synephrine (phenylephrine) is still used as a sympathomimetic (i.e. for its hypertensive and vasoconstrictor properties), mostly by injection for the treatment of emergencies such as shock, and rarely orally for the treatment of bronchial problems associated with asthma and hay-fever. Its benefits are weight loss/weight management; increases sport performance, appetite control, increases energy, mental focus, and cognition. Various studies indicate that p-synephrine exerts these effects through such mechanisms as binding to β_3-adrenergic receptors, which regulate lipid and carbohydrate metabolism.

- ***Eriocitrin: -***

Eriocitrin (eriodictyol glycoside) is a flavanone-7-*O*-glycoside between the flavanone eriodictyol and the disaccharide rutinose. It is commonly found in lemons. It is colloquially called lemon flavonoid or a citrus flavonoid, one of the plant pigments that bring color to fruit and flowers. It has lipid-lowering properties in liver cells. It is anti-inflammatory; it is marketed as a dietary supplement, usually in conjunction with B and C vitamins and other substances, but there is no established medical use or FDA approved application of the compound.

- ***Tageretin, nobiletin, sinensetin: -***

The peels of citrus fruits are rich in the polymethoxylated flavones, tageretin, nobiletin and sinensetin; they have a double bond between positions 2 and 3 and a ketone in position 4 of the C ring. It is under researches.

- ***Acacetin: -***

Acacetin (5,7-dihydroxy-4'-methoxyflavone) exerts anti-plasmodial, anti-mutagenic, anti-inflammatory, anti-peroxidant, and anticancer effects by suppressing the migration and invasion of human cancer cells. Acacetin has also been shown to exert an anti-proliferative effect by blocking cell cycle progression and inducing apoptosis. It is phenolic flavonoids compound.

- ***Acrignine A, baiyumine A & B: -***

It is acrignine-A is an acridone alkaloid carrying lignan moiety, from roots of Citrus plants (Rutaceae); it is under research. Also 5-hydroxyacronycine, acriginine A, Atalafoline, Baiyumine A and B, Buntanine, Buntanmine, Grandisine I and II, Pumiline, honyumine, natsucrin, Prenyl citpressine, Citropone A and B, Glycocitrine I were reported in the roots and the bark of Citrus maxima & caffeine are assayed in the flowers of the C. maxima. They all are under research.

- ***Grandisine I & II: -***

Two novel indolizidine alkaloids, grandisine A (1) and B (2), and the known alkaloid (−) isoelaeocarpiline (3) were isolated from the leaves of Elaeocarpus grandis and their structures determined by 1D and 2D NMR spectroscopy. The compounds showed affinity for the human δ-opioid receptor. Grandisine A contains a unique tetracyclic skeleton, while grandisine B possesses the unique combination of isoquinuclidinone and indolizidine groups in one molecule.

- ***Methoprene: -***

Methoprene is the common name for isopropyl-(2*E*,4*E*,7*R*,*S*)-11-methoxy-3,7,11-trimethyldodeca-2,4-dienoate. It is a racemic mixture of two enantiomers (R and S in a ratio of 1:1). The activity of the compound as a juvenile hormone is restricted to the S enantiomer.

- ***Alpha-copaene: -***

Alpha-copaene, also known as copaene, is a member of the class of compounds known as sesquiterpenoids. Sesquiterpenoids are terpenes with three consecutive isoprene units. Alpha-copaene is a spice and woody tasting compound and can be found in a number of food items such as lime, mandarin orange (clementine, tangerine), safflower, and summer savory, which makes alpha-copaene a potential biomarker for the consumption of these food products. Alpha-copaene can be found primarily in feces and saliva. It possesses antioxidant, cytotoxic and antigenotoxic properties.

- ***Citral: -***

Citral, or 3,7-dimethyl-2,6-octadienal or lemonal, is either a pair, or a mixture of terpenoids with the molecular formula $C_{10}H_{16}O$. The two compounds are geometric isomers. The *E*-isomer is known as geranial or citral A. The *Z*-isomer is known as neral or citral B. Citral is present in the oils of several plants, including lemon myrtle (90–98%), *Litsea citrata* (90%), *Litsea cubeba* (70–85%), lemongrass (65–85%), Citral has a strong lemon (citrus) odor. Neral's lemon odor is less intense, but sweeter. Citral is therefore an aroma compound used in perfumery for its citrus effect. It is antimicrobial.

- ***Neral: -***

Neral, also known as cis-citral or citral b, is a member of the class of compounds known as acyclic monoterpenoids. Acyclic monoterpenoids are monoterpenes that do not contain a cycle. Thus, neral is considered to be an isoprenoid lipid molecule. Neral is practically insoluble (in water) and an extremely weak basic (essentially neutral) compound (based on its pKa). Neral is a sweet, citral, and lemon tasting compound.

- ***Citronella: -***

Citronellal or rhodinal or 3,7-dimethyloct-6-en-1-al (C10H18O) is a monoterpenoid, the main component in the mixture of terpenoid chemical compounds that give citronella oil its distinctive lemon scent. It is an insect repellent, antifungal agent, treat parasitic infections, promotes wound healing, lift mood or fight fatigue used in perfumes or as a flavor additive in food.

- ***Citropten: -***

Citropten is a natural organic compound with the molecular formula $C_{11}H_{10}O_4$. It is found in the essential oils of citrus such as lime, lemon, and bergamot.

- ***Diosmin: -***

Diosmin (diosmetin 7-O-rutinoside), a flavone glycoside of diosmetin, is manufactured from citrus fruit peels as a non-prescription dietary supplement used to aid treatment of hemorrhoids or chronic venous diseases, mainly of the legs. Diosmin is a dietary supplement used to aid treatment of hemorrhoids and venous diseases.

- ***Coumarin: -***

It is oxygen containing heterocyclic compound; it is among polyphenolic compound present in many plants; it is colourless, crystalline phytochemical; it belongs to benzopyrones family; it is found in many essential oils.

Main sources of coumarin: -

Fenugreek, cassia cinnamon, vanilla grass, cucumber etc.

Basic pharmacokinetics of coumarin (based on human intake in natural food products): -

It is absorbed rapidly in small intestines & metabolized in liver, very less is known about its digestion. It is stored in liver, kidney, brain, heart, lungs, muscles; it crosses the blood brain barrier; it is excreted in urine mainly & little in stool.

Basic clinical pharmacology of coumarin: -

It is anti inflammatory, anti tumour, anti bacterial, anti oxidant, anti coagulant etc.

- ***Bergamottin (furanocoumarins): -***

Bergamottin (5-geranoxypsoralen) is a natural furanocoumarin found in the pulp of pomelos and grapefruits. It is also found in the peel and pulp of the bergamot orange, from which it was first isolated and from which its name is derived. Along with the chemically related compound dihydroxybergamottin, it is believed to be responsible for a number of grapefruit–drug interactions, in which the consumption of citrus containing one or both of these compounds (especially grapefruit) affects the metabolism of a variety of pharmaceutical drugs. 5-geranoxypsoralen (5-GOP), commonly called bergamottin, is a highly photoreactive psoralen, which in contrast to most furocoumarins, does not strongly interact with DNA. 5-GOP gives the opportunity to study, in a more selective way, the mechanisms of phototoxic and immunological activities induced by psoralen and UVA

radiation. Isopimpinellin, imperatorin are among furanocoumarin & researches reveal that it is anti-breast cancer.

- ***Herniarin: -***

Herniarin is a natural chemical compound; it can be considered a methoxy derivative of coumarin or a methyl derivative of umbelliferone. It is under research. Herniarin, also known as 7-methoxycoumarin or ayapanin, belongs to the class of organic compounds known as coumarins and derivatives. These are polycyclic aromatic compounds containing a 1-benzopyran moiety with a ketone group at the C2 carbon atom (1-benzopyran-2-one). Herniarin is an extremely weak basic (essentially neutral) compound (based on its pKa). Herniarin is a sweet, balsamic, and tonka tasting compound. Herniarin has been detected, but not quantified in, several different foods, such as tarragons, german camomiles, wild celeries, barley, and roman camomiles. This could make herniarin a potential biomarker for the consumption of these foods.

- ***Umbelliferone: -***

Umbelliferone, also known as hydrangin or skimmetin, belongs to the class of organic compounds known as 7-hydroxycoumarins. These are coumarins that contain one or more hydroxyl groups attached to the C7 position the coumarin skeleton.

- ***Cyclopentanedione: -***

3-Isopropyl-1,2-cyclopentanedione belongs to the class of organic compounds known as cyclic ketones. These are organic compounds containing a ketone that is conjugated to a cyclic moiety. 3-Isopropyl-1,2-cyclopentanedione is an extremely weak basic (essentially neutral) compound (based on its pKa). 3-Isopropyl-1,2-cyclopentanedione has been detected, but not quantified in, coffee and coffee products. This could make 3-isopropyl-1,2-cyclopentanedione a potential biomarker for the consumption of these foods.

- ***Psoralen: -***

Psoralen (also called psoralene) is the parent compound in a family of naturally occurring organic compounds known as the linear furanocoumarins. It is structurally related to coumarin by the addition of a fused furan ring, and may be considered as a derivative of umbelliferone.

- ***Oxypeucedanin: -***

Oxypeucedanin hydrate, also known as aviprin, is a member of the class of compounds known as psoralens. Psoralens are organic compounds containing a psoralen moiety, which consists of a furan fused to a chromenone to for 7H-furo[3,2-g]chromen-7-one. Oxypeucedanin hydrate is practically insoluble (in water) and a very weakly acidic compound.

- ***Byakangelicol: -***

Byakangelicol is a member of the class of compounds known as 5-methoxypsoralens. 5-methoxypsoralens are psoralens containing a methoxy group attached at the C5 position of the psoralen group. Byakangelicol is practically insoluble (in water) and an extremely weak basic (essentially neutral) compound (based on its pKa). Byakangelicol can be found in lemon, which makes byakangelicol a potential biomarker for the consumption of this food product.

- ***Byakangelicin (mukurozidiol): -***

Mukurozidiol, also known as byak-angelicin, belongs to the class of organic compounds known as 5-methoxypsoralens. These are psoralens containing a methoxy group attached at the C5 position of the psoralen group. Mukurozidiol is an extremely weak basic (essentially neutral) compound (based on its pKa). Mukurozidiol has been detected, but not quantified in, a few different foods, such as citrus, herbs and spices, and lemons. This could make mukurozidiol a potential biomarker for the consumption of these foods.

- ***Cyclohexanediol: -***

Cyclohexane-1,2-diol is a chemical compound found in castoreum. It can exist in either *cis*- or *trans*-isomers.

- ***Isospathulenol: -***

Isospathulenol belongs to the class of organic compounds known as 5,10-cycloaromadendrane sesquiterpenoids. These are aromadendrane sesquiterpenoids that arise from the C5-C10 cyclization of the aromadendrane skeleton. Isospathulenol is an extremely weak basic (essentially neutral) compound (based on its pKa).

- ***Isopulegol: -***

Isopulegol belongs to the class of organic compounds known as menthane monoterpenoids. These are monoterpenoids with a structure based on the o-, m-, or p-menthane backbone. P-menthane consists of the cyclohexane ring with a methyl group and a (2-methyl)-propyl group at the 1 and 4 ring position, respectively. The o- and m- menthanes are much rarer, and presumably arise by alkyl migration of p-menthanes (-)-Isopulegol is an extremely weak basic (essentially neutral) compound (based on its pKa).

- ***Decanal: -***

Decanal is an organic compound with the chemical formula C9H19CHO. It is the simplest ten-carbon aldehyde. Decanal occurs naturally and is used in fragrances and flavoring. Decanal occurs in nature and is an important component in citrus along with octanal, citral, and sinensal. Decanal is also an important component of buckwheat odour. Decanal is found in many foods, some of which are lime, citrus, fats and oils, and garden tomato (variety).

- ***Elemene: -***

Beta-elemene, also known as B-elemen or 2,4-diisopropenyl-1-methyl-1-vinylcyclohexane, is a member of the class of compounds known as elemane sesquiterpenoids. Elemane sesquiterpenoids are sesquiterpenoids with a structure based on the elemane skeleton. Elemane is a monocyclic compound consisting of a cyclohexane ring substituted with a methyl group.

- ***Cadinol: -***

Cadinol is also known as alpha-cadinol. Cadinol is practically insoluble (in water) and an extremely weak basic (essentially neutral) compound (based on its pKa). Cadinol can be found in spearmint, which makes cadinol a potential biomarker for the consumption of this food product. Cadinol is any of several organic compounds with formula C 15H 26O, especially: α-cadinol δ-cadinol (torreyol, sesquigoyol, pilgerol, albicaulol) T-cadinol.

- ***Phellopterin: -***

Phellopterin is a member of the class of compounds known as 5-methoxypsoralens. 5-methoxypsoralens are psoralens containing a methoxy group attached at the C5 position of the psoralen group. Phellopterin is practically insoluble (in water) and an extremely weak basic (essentially neutral) compound (based on its pKa). Phellopterin can be found in lemon, lime, and wild celery, which makes phellopterin a potential biomarker for the consumption of these food products.

- ***Octopamine: -***

Octopamine (molecular formula $C_8H_{11}NO_2$; also known as para-octopamines and others) is an organic chemical closely related to norepinephrine, and synthesized biologically by a homologous pathway. Its name derives from the fact that it was first identified in the salivary glands of the octopus. In many types of invertebrates (in the salivary glands of the octopus etc); it is an important neurotransmitter and hormone. It is commonly used for weight loss and athletic performance.

- ***Phenethylamine: -***

Phenethylamine (PEA) is an organic compound, natural monoamine alkaloid, and trace amine, which acts as a central nervous system stimulant in humans. It help the brain in many functions;

in orally ingested phenethylamine, a significant amount is metabolized in the small intestine by monoamine oxidase B (MAO-B) and then aldehyde dehydrogenase (ALDH), which convert it to phenylacetic acid. This means that for significant concentrations to reach the brain, the dosage must be higher than for other methods of administration. It helps the brain function, reduces brain fatigue, fog (fuzzy thinking), poor concentration/attention/focus, lack of motivation.

- ***N-methyltyramine: -***

N-Methyltyramine (NMT), also known as 4-hydroxy-N-methylphenethylamine, is a human trace amine and natural phenethylamine alkaloid found in a variety of plants. As the name implies, it is the N-methyl analog of tyramine, which is a well-known biogenic trace amine with which NMT shares many pharmacological properties. N-methyltyramine is most often used for weight loss. Scientists have found that chemicals that are similar to N-methyltyramine help to break down fat in fat cells. However, N-methyltyramine doesn't seem to break down fat. In fact, it might increase appetite and slow down the breakdown of fat in fat cells.

- ***Tyramine: -***

Tyramine is also spelled tyramin, also known under several other names, is a naturally occurring trace amine derived from the amino acid tyrosine. Tyramine acts as a catecholamine releasing agent. It is an amino acid that helps regulate blood pressure. It occurs naturally in the body; Tyramine is a compound produced by the breakdown of an amino acid called tyrosine. It's naturally present in some foods, plants, and animals. It is a vasoactive amine that promotes blood pressure elevation, resulting in pain & leads to cerebral vasoconstriction and subsequent rebound vasodilatation that causes a migraine attack in susceptible persons.

- ***Limonene: -***

It is a cyclic monoterpene & is the major component in the oil of citrus fruit peels; it is soluble in water; it has a pleasant aroma.

Main sources of limonene: -

It is present in orange, orange peel, grapes, lemon, lime, mandarins & marjoram.

Basic pharmacokinetics of limonene (based on human intake in natural food products): -

Limonene is completely absorbed when taken orally; it can be absorbed by inhalation up to 70%; it can be also absorbed by skin; it is distributed throughout the body & fats tissues; it is metabolized in liver & excreted in urine.

Basic clinical pharmacology of limonene: -

it is anti-inflammatory, antioxidant, anti-stress, prevents diseases, it is a natural insect repellant, it is used as an additive & flavouring agent, it is used in shampoo, soaps, perfumes detergent making, also used in laundry, cosmetics, air fresher etc. It is also available in concentrated supplement in capsules & liquid form; it is anti-inflammatory, antioxidant, anti-cancer, heals heart disease, strengthens the heart, reduces stress, anxiety and improves digestion.

- ***Humulene: -***

It is also known as a-caryophyllene; it is a monocyclic sesquiterpene; it is present in humulus lupulus oil (hops) & salvia officinalis (common sage, culinary sage), lindera strychrifolia, ginseng, ginger, mentha spicata etc; it is often present with Beta-caryophyllene; It has woody aroma; it is anti inflammatory, anti arthritis, anti fibromyalgia etc.

- ***Muurolene: -***

It is a sesquiterpene & a carbo-bicyclic compound; it is mainly of two types alpha & gamma, both are similarly; both are neuro-protective, anti nociceptive; it is also present in ptychopetalum olaciodes.

- ***Camphene: -***

Camphene is a bicyclic monoterpene. It is nearly insoluble in water, but very soluble in common organic solvents. It volatilizes readily at room temperature and has a pungent smell. It is used in creams, salves & lotions because it is good for eczema and psoriasis, anti-fungal and antibacterial

- ***Farnesene: -***

The term farnsene refers to a set of six closely related chemical compounds which all are sesquiterpenes; it is found in alpha & beta form, both are similar with little difference but alpha is most common & found in apple coats, perilla oil; it is anti anxiety, anti spasmodic, calming, sedative, muscles relaxant, anti inflammatory, anti fungal, anti bacterial; it is used in cosmetics, perfumes etc.

- ***Germacrene d: -***

It is a volatile sesquiterpene & amongst essential oils; it is found in many species & is of two prominent molecules Germacrene A & D; D is present mainly in lamium purpureum, clausena auisata, basil, clary sage etc.

- ***Beta-caryophyllene: -***

It is the most commonly occurring form in many essential oils, particularly oil of cloves. It has a role as a non-steroidal anti-inflammatory drug, a fragrance, a metabolite and an insect attractant, analgesic, antipyretic, and platelet-inhibitory actions. They act by blocking the synthesis of prostaglandins by inhibiting cyclooxygenase, which converts arachidonic acid to cyclic endoperoxides, precursors of prostaglandins. Inhibition of prostaglandin synthesis accounts for their analgesic, antipyretic, and platelet-inhibitory actions; other mechanisms may contribute to their anti-inflammatory effects.

- ***Zonarene: -***

Zonarene is a member of the class of compounds known as sesquiterpenoids. Sesquiterpenoids are terpenes with three consecutive isoprene units. Zonarene can also be found in allspice, cloves, and ginger, which makes zonarene a potential biomarker for the consumption of these food products.

- ***Linalyl acetate***

Linalyl acetate is a naturally occurring phytochemical found in many flowers and spice plants. It is one of the principal components of the essential oils of bergamot and lavender. Chemically, it is the acetate ester of linalool, and the two often occur in conjunction. It is anti-inflammatory, antioxidant, helps in controlling blood pressure & antimicrobial.

- ***Neryl acetate: -***

It is also called as Geranyl acetate, also known as neryl ethanoate or fema 2509, belongs to the class of organic compounds known as fatty alcohol esters. These are ester derivatives of a fatty alcohol. Geranyl acetate is a very hydrophobic molecule, practically insoluble (in water), and relatively neutral. Geranyl acetate is a potentially toxic compound.

- ***Decyl acetate: -***

Decyl acetate, also known as 1-decanol acetate or decyl ethanoate, belongs to the class of organic compounds known as fatty alcohol esters. These are ester derivatives of a fatty alcohol. Decyl acetate is a very hydrophobic molecule, practically insoluble (in water), and relatively neutral. Decyl acetate is found in citrus. Decyl acetate is a flavouring agent. Decyl acetate is present in citrus peels, apple, melon, strawberry, celery and other foodstuffs. Decyl acetate is used in apple, orange and rum flavours.

- ***Gamma-Aminobutyric acid: -***

Gamma-Aminobutyric acid, or γ-aminobutyric acid, or GABA is the chief inhibitory neurotransmitter in the developmentally mature mammalian central nervous system. Its principal role is reducing neuronal excitability throughout the nervous system. GABA is sold as a dietary supplement. It reduces anxiety, improving mood, reducing symptoms of premenstrual syndrome (PMS), and treating attention deficit-hyperactivity disorder (ADHD). It is also used for promoting lean muscle growth, burning fat, stabilizing blood pressure, and relieving pain.

- ***Alkanes: -***

Alkanes are organic compounds that consist entirely of single-bonded carbon and hydrogen atoms and lack any other functional groups. Alkanes have the general formula CnH2n+2 and can be subdivided into the following three groups: the linear straight-chain alkanes, branched alkanes, and cycloalkanes.

- ***Triterpenes: -***

It is a natural group of plant product (saponins); it is of two types simple & complex, simple are components of surface waxes & specialized membranes & act as signaling molecules; complex are glycosylated & provide protection to the plant against pathogen & pests.

Main sources of Triterpenes: -

Olive oil, olive leaves, olive fruits, rosemary, cucumber, it is present in plant surface such as stem bark, leaf, fruit waxes of many plants specially of Lamiaceae family.

Basic pharmacokinetics of Triterpenes (based on human intake in natural food products): -

Before absorption it is hydrolyzed by intestinal enzymes or by bacterial enzymes in large intestine and absorbed; it has low absorption rate; not much is known about its digestion.

Basic clinical pharmacology of Triterpenes: -

It is anti tumour, anti viral, anti bacterial, anti oxidant, anti diabetes, cardio protective, anti obesity, anti cancer, anti ulcer, anti inflammatory, immune-modulator, resolve immune diseases.

- ***Carbamate: -***

A carbamate is a chemical compound that is formally derived from carbamic acid (NH2COOH). The term includes organic compounds (e.g., the ester ethyl carbamate), formally obtained by replacing one or more of the hydrogen atoms by other organic functional groups; as well as salts with the carbamate anion H2NCOO−(e.g. ammonium carbamate). It is insecticides, fungicides, nematocides.

- ***Hesperidine: -***

Hesperidin, a flavanone glycoside, is a natural phenolic compound with a wide range of biological effects. Mounting evidence has demonstrated that hesperidin possesses inhibitory effect against development of neuro-degenerative diseases.

- ***Anthocyanin: -***

It is a type of flavonoid & is the pigments that give red, purple & blue plants their rich colouring.

Main sources of anthocyanin: -

Black soybean, pomegranate, black berries, cherries, grape, plums etc.

Basic pharmacokinetics of anthocyanin: -

Its absorption, metabolism & excretion are not known yet and are under research.

Basic clinical pharmacology of anthocyanin: -

It is a strong anti oxidant, anti cancer, anti inflammatory, removes free radicals from the body, prevents heart diseases, blood pressure, infections, urinary infections, cough & cold.

- ***Beta-cryptoxanthin: -***

Beta-cryptoxanthin is a common carotenoid that is found in fruit, and in human blood and tissues. Foods that are rich in beta-cryptoxanthin include tangerines, persimmons and oranges. Beta-cryptoxanthin has several functions that are important for human health, including roles in antioxidant defense and cell-to-cell communication. Most importantly, beta-cryptoxanthin is a precursor of vitamin A, which is an essential nutrient needed for eyesight, growth, development and immune response.

- ***Lycopene: -***

It is a phytochemical of bright red colour carotene & carotenoid; it gives the red colour to the watermelon & other vegetables & fruits like tomato, pink guava, pink grapes, papaya etc. but it is not found in cherry & strawberries, although lycopene is chemically carotene but it has no vitamin A.

Main sources of lycopene: -

It is present in watermelon, olive, pink grapes, papaya, pink guava, grapes etc.

Basic pharmacokinetics of lycopene (based on human intake in natural food products): -

Absorption of it requires bile salts & fats to form a colloidal liquid & mostly absorbed in intestines. It is stored in the body in liver, testes, adrenal glands, ovaries, lungs, prostate gland & plasma; its excretion is not unknown. But if taken in higher doses it was found to be excreted in urine & stools both depending on the dose but when intake in natural fruits or vegetables the amount of it present is very little, that do not matter how it is excreted.

Basic clinical pharmacology of lycopene: -

It is a powerful antioxidant & anti inflammatory thus prevents many types of cancers; it also reduces risk of cardio vascular disease because it helps in keeping the blood pressure normal; it prevents skin from various changes & degeneration, due its antioxidant action cleaning the skin from harmful effects of UV rays; it removes free radicals from the body which float in the body disrupting cells & causing deadly diseases like cancer, asthma, auto-immune diseases etc; it is also helpful in hair health & its problems; it inhibit 5 alpha reductase (means dihydrotestosterone blocker) & reduces PSA (prostate specific antigen) thus helpful in prostate enlargement & prostate cancer; also makes bones strong.

- ***Citric acid: -***

Citric acid is a weak organic acid that has the chemical formula C 6H 8O 7. It occurs naturally in citrus fruits. Benefits of citric acid are: when applied to skin, citric acid can slough off dead skin cells and speed new cell turnover. The latter promotes new skin growth that can help alleviate the appearance of age spots, acne scars, small wrinkles and areas of uneven tone and texture.

- ***Citrate: -***

Citric acid is a weak organic acid that has the chemical formula $C_6H_8O_7$. It occurs naturally in citrus fruits; it helps to break kidney stone & prevents kidney stone.

- ***Pinene: -***

It is a bicyclic monoterpene chemical compound. There are two structural isomers of pinene found in nature: α-pinene and β-pinene. As the name suggests, both forms are important constituents of pine resin; they are also found in the resins of many other conifers, pine tree, maktur tree oil, lime fruit peel, as well as in non-coniferous plants such as camphorweed (*Heterotheca*) and big sagebrush (*Artemisia tridentata*). It is anti-inflammatory, bronchodilator, antianxiety, anti-pain etc.

- ***Myrcene: -***

It is monoterpene & is olefinic natural organic hydrocarbon; its aroma is earthy, fruity & clove like; it is pungent, it synergizes activity of terpenes & it has a role as a plant metabolite etc.

It is present in wild thyme leaves, cannabis, hops, lemon grass, mango, myrica, verbena, cardamom, West Indian bay tree, marjoram, houttuynia, basil etc.

It is useful in treating diabetes, diarrhea, dysentery, blood pressure, reduces pain, increases transdermal absorption, improves glucose tolerance, good for osteoarthritis, also used as flavouring agent, perfume making etc; it crosses blood brain barrier & increases the transport of cannabinoids in the brain,), it is a significant analgesic. It is under research & its absorption, metabolism is not known. It is anti anxiety, anti depressant, sedative, anti inflammatory, anti epileptic, increase immunity.

- ***Phellandrene: -***

In Marjoram alpha & beta phellandrene are present; it is a pair of organic compound that have a similar molecular structure & similar chemical properties; both alpha & beta are cyclic monoterpenes & are double-bond isomer. In alpha both double bond are endocyclic & in beta one double bond is exocyclic; both are soluble in water; they have a pleasant aroma & peppery taste.

Alpha is potential immune stimulator, anti-fungal, anti inflammatory, anti-cancer, anti pain, develop natural killer (NK) in the body, boost immune system; beta is anti microbial, anti-fungal, antioxidant; both are believed to be excreted in stools,

Beta is present in oil of following bitter fennel, elemi, ginger-grass, ridolfia segetum & alpha is present in oil of cinnamon, dill, turmeric, ceylon etc.

- ***Terpinene: -***

Terpinene are group of isomeric hydrocarbons & classified as monoterpenes; Alfa terpinene is isolated from cardamom & marjoram oil & from other natural sources, but beta terpinene is made artificially (compounding).

Natural sources of it are cuminum cyminum, melalenca alternifolia, cannabis, apples, tea, cumin, nutmeg, rosemary etc. It has a pleasant aroma & flavour; it is used in manufacturing soaps, perfumes, lotions, insect repellent; it reduces anxiety because it is sedative, it is anticancer, antioxidant.

- ***Limonene: -***

It is a cyclic monoterpene & is the major component in the oil of citrus fruit peels; it is soluble in water; it has a pleasant aroma.

Main sources of limonene: -

It is present in orange, orange peel, grapes, lemon, lime, mandarins & marjoram.

Basic pharmacokinetics of limonene (based on human intake in natural food products): -

Limonene is completely absorbed when taken orally; it can be absorbed by inhalation up to 70%; it can be also absorbed by skin; it is distributed throughout the body & fats tissues; it is metabolized in liver & excreted in urine.

Basic clinical pharmacology of limonene: -

it is anti-inflammatory, antioxidant, anti-stress, prevents diseases, it is a natural insect repellant, it is used as an additive & flavouring agent, it is used in shampoo, soaps, perfumes detergent making, also used in laundry, cosmetics, air fresher etc. It is also available in concentrated supplement in capsules & liquid form; it is anti-inflammatory, antioxidant, anti-cancer, heals heart disease, strengthens the heart, reduces stress, anxiety and improves digestion.

- ***Carvone: -***

It gives black seeds a special taste & odour; it is a volatile terpenoid. Its absorption, metabolism is not known.

Main sources of carvone: -

Black seed, dill seed, orange peel oil, spearmint, mandarin.

Basic clinical pharmacology of carvone: -

It is a decongestant, diuretic, anti viral, anti tumour, carminative, cardio-protective, stomachic, prevents bronchitis, asthma, cough, laryngitis, sore throat, colicky pain, urinary infection, reduces and relief gastric spasm.

- ***Damascenone: -***

Damascenones are a series of closely related chemical compounds that are components of a variety of essential oils. The damascenones belong to a family of chemicals known as rose ketones.

- ***Ionones: -***

The terpene, β-ionone is largely responsible for the pungent odour of the essential oil isolated from the flowers. Both beta & alpha are present in henna oil; it is under research.

- ***Butyric acid: -***

Natural butyric acid present in honey prevent mites & viral infections among the bees; it is also artificially used as a mite repellent in honey hive by honey harvester.

- ***Butanoate: -***

Butyrate or butanoate is the traditional name for the conjugate base of butyric acid (also known as butanoic acid). The name is used as part of the name of esters and salts of butyric acid. Butyrate seems to also lower your risk for obesity, diabetes and colon cancer.

- ***Arachidic acid: -***

It is also called as Eicosanoic acid; it is among omega 6 fatty acid; human body uses it as a starting material in synthesis of 2 kinds of essential substances (prostaglandin & leukotrienes both are unsaturated carboxylic acid).

Main sources of arachidic acid: -

It is present in meat, fish, seafood, egg, chicken, peanut oil, corn oil etc.

Basic pharmacokinetics of arachidic acid (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of arachidic acid: -

It is eaten by body builders to gain muscles due to its inflammatory action in the body; it leads to increase production of eicosaniods that help raise immunity, inflammatory response in human body, it also reduces depression, increases lean muscles.

- ***Behenic acid: -***

It has a very long-chain of saturated fatty acids; it is also called as docosanoic acid.

Main sources of behenic acid: -

It is present in pumpkin seed oil, moringa oleifera seed oil, rape seed oil, peanut oil etc.

Basic pharmacokinetics of behenic acid (based on human intake in natural food products): -

It is poorly absorbed in human body; its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of behenic acid: -

It is smooth & moisturizing in nature thus good & helpful for skin & hair.

- ***Linoleic acid: -***

It is a carboxylic acid, it make up 3% to 15% of extra virgin olive oil, It is polyunsaturated with omega 3 & 6 fatty acids; its short hand notation is 18:2, it is an essential fatty acid that must be consumed for health.

Main sources of linoleic acid: -

It is present in olive oil, evening primrose oil, sunflower oil, walnut oil, hemp oil, grape seed oil, safflower oil, egg yolk, butter & etc.

Basic pharmacokinetics of linoleic acid (based on human intake in natural food products): -

It is first hydrolyzed from dietary fats & pancreatic enzymes & then with the help of bile it is absorbed in small intestine; metabolism & excretion are under research.

It gets converted into gamma linoleic acid (GLA) in the body, GLA is converted in the body into dihomo GLA (20 carbon chain) & it is converted into Arachidonic acid which is converted into Docosatetraenoic (long chain fatty acid with 22 carbons) acid.

Basic clinical pharmacology of linoleic acid: -

It acts on prostaglandin system of the body thus is anti-inflammatory, blood thinner, vasodilator (expand the blood vessel) it is very helpful in treatment of rheumatoid arthritis, breast lumps, fibro-adenoma (nodes in breast), cancers, reduces cholesterol, it prevents heart disease, diabetes, skin ulcers, irritable bowel syndrome etc.

- ***Linolenic acid (ALA): -***

It is an omega 3 fatty acid, it essential fatty acid necessary for health & cannot be produced in human body, it is also called as ALA (alpha linolenic acid). It is the substrate for the synthesis of longer-chain, more unsaturated fatty acids eicosapentaenoic acid (EPA) & docosahexaenoic acid (DHA) required for tissue function.

Main sources of linolenic acid (ALA): -

Flax seed oil, rape seed oil, soybean, pea leaves, fish oil, evening primrose oil, vegetable oil, walnut, meat, grape seed oil.

Basic pharmacokinetic of ALA (based on human intake in natural food products): -

Same as omega 6

Basic clinical pharmacology of ALA: -

It is useful to prevent heart disease, control blood pressure, control cholesterol, prevents & reverse atherosclerosis, it is anti inflammatory, anti obesity, anti cancer, reduces fibroadenoma, breast lumps, good & helpful for skin, nail, hair, brain, organs.

- ***Palmitic acid: -***

It makes up 7% to 13% of extra virgin olive oil; it is a common saturated fatty acid; it is the first fatty acid produced during lipogenesis (fatty acid synthesis) & from which longer fatty acids can be produced.

Main sources of palmitic acid: -

It is present in olive oil, flaxseed oil, soyabean oil, sunflower oil, palm oil, cocoa butter, meat, milk & etc.

Basic pharmacokinetics of palmitic acid (based on human intake in natural food products): -

Its absorption, metabolism & excretion are under research.

Basic clinical pharmacology of palmitic acid: -

It softens the skin & keeps it moist thus good for psoriasis & eczema. It coats the skin, it is powerful anti-oxidant; it maintains the health of hair & skin from aging, cleans them from dirt, sweat, excessive sebum (main cause of acne and boil on face & other parts of the body).

- ***Stearic acid: -***

It makes up 0.5% to 5 % of extra virgin olive oil; it is saturated fatty acid. It is also known as octadecanoic acid.

Main sources of stearic acid: -

It is mainly present in olive oil, also present in butter, whole milk, yeast bread, egg & etc.

Basic pharmacokinetics of stearic acid (based on human intake in natural food products): -

Its absorption, metabolism & excretion are under research.

Basic clinical pharmacology of stearic acid: -

It cleans the skin & removes dirt, sweat & excessive sebum from skin & hair. The colour of olive oil is due to pigments of stearic acid like chlorophyll, pheophytin & carotenoid that's why extra virgin olive oil has colour of its own which refined & pomace do not have.

- ***Tetracosanoic acid: -***

Tetracosanoic acid is a C24 straight-chain saturated fatty acid. It is also called as Lignoceric acid; it has a role as a volatile oil component, a plant metabolite, a human metabolite and a Daphnia tenebrosa metabolite. It is a very long-chain fatty acid and a straight-chain saturated fatty acid. It is a conjugate acid of a tetracosanoate. It is anti-ageing.

- ***Tocopherol: -***

Tocopherol is among class of organic compound; fat-soluble compound with vitamin E activity, is best known for its antioxidant activity. It is synthesized only in photosynthetic organisms and acts as a protective component. It is antioxidants with the power to reduce inflammation, potentially promoting anti-cancer, anti-aging, and other benefits.

- ***Thujene: -***

It is referred as alpha-thujene; it is a monoterpene found in many essential oils of plants; it is similar to sabinene; it is present in marjoram oil, boswellia serrata oil, eucalyptus oil, it has a pungent taste, green herbal woody smell, it is yellowish transparent; it is anti inflammatory, anti-arthritis, antimicrobial, insecticide.

- ***Bisabolene: -***

Bisabolenes are a group of closely related natural chemical compounds which are classified as sesquiterpenes; it is present in many plants; it is anticancer, anti-tumour.

- ***Curcumene: -***

Alpha-Curcumene, also known as (R)-curcumene or L-α-curcumene, belongs to the class of organic compounds known as sesquiterpenoids. It is mainly present turmeric; it has lot of health benefits, such as the potential to prevent heart disease, Alzheimer's and cancer. It's a potent anti-inflammatory and antioxidant and may also help improve symptoms of depression, arthritis; it is antibacterial, antiviral best cough & cold & infections.

- ***P-cymene: -***

It is a naturally occurring aromatic organic compound; it is insoluble in water, it has a mild pleasant odour; it floats on water; it is a hydrocarbon mono-terpene; it is present in many essential oils (mainly in cumin & thyme oil).

Main sources of p-cymene: -

Cumin oil, thyme oil, basil oil, carrot seed oil, clove bud oil, angelica root & seed oil, grape fruit oil, eucalyptus oil.

Basic pharmacokinetics of p-cymene (based on human intake in natural food products): -

It is well absorbed through skin; little excreted unchanged & remainder being oxidized to water-soluble metabolism.

Basic clinical pharmacology of p-cymene: -

It is anti inflammatory, reduces pulmonary oedema, it is used for flavouring cakes, beverages, confectionaries, fragrances etc; it is anti bacterial, anti fungal, analgesic, antioxidant, anxiolytic, anticancer, antinociceptive.

- ***Sabinene: -***

It is a natural thujene bicyclic monoterpene; it is also called as Thujene, sabanene etc; it has woody & spicy smell, it is also used in perfume making & as a flavouring agent in eatables; it is mainly present in black pepper, carrot, seed oil, tea tree oil, nutmeg oil, bay tree, horse wood tree, Norway spruce, marjoram etc; it is strong anti bacterial that also gram positive bacterias, and is anti-fungal, antiseptic, anti helicobacter, anti ulcer, anti inflammatory, antioxidant, inhibits nitric oxide.

- ***Auraptene: -***

Isolated from Citrus aurantium (Seville orange) and bael fruit (Aegle marmelos) Auraptene is natural bioactive monoterpene coumarin ether. It was first isolated from members of the genus Citrus. Auraptene has shown a remarkable effect in the prevention of degenerative diseases. Many studies have reported the effect of auraptene as a chemopreventative agent against cancers of liver, skin, tongue, esophagus, and colon in rodent models. The effect in humans is not yet known. Auraptene is found in many foods, some of which are citrus, fruits, sweet orange, and lemon.

- ***Geraniol: -***

It is a mono-terpene found in many essential oils of fruits & vegetables, herbs like rose oil, citronella, lemon grass, lavender, thyme oil etc. it is emitted from flowers of many spices of plants & used in food, fragrance & cosmetic products; it is microbial, anti inflammatory, antioxidant, anti cancer, neuro-protective, anti cancer, anti tumour. It is colourless or little yellowish, slightly water soluble & has a sweet odour rose oil like; its absorption, metabolism is not known.

- ***Ocimene: -***

It is a monoterpene & among group of isomeric hydrocarbons; it is often found naturally as mixture of various forms (in oil); it has pleasant odour sweet & herbaceous; it is used in perfumes making; it is insoluble in water, but soluble in common organic solvents; it is anti-fungal, anti bacterial, insecticidal.

- ***Chlorogenic acid: -***

It is the ester of caffeic acid & quinic acid; it is among polyphenol & present mainly in coffee; it has similar action & effect to caffeine, but less potent; it reduces the absorption of carbohydrate, reduces blood glucose, blood pressure & is anti-obesity, improves mood.

It is mainly present in apples, pear, carrot, tomato, sweet potato, coffee, thyme, tea, marjoram etc.

- ***Spathulenol: -***

It is a tricyclic sesquiterpene, it is similar to azulenes (azulene is an organic compound & an isomer of naphthalane hydrocarbon white crystalline solid compound, it has a speacially odour); sapthulenol is mainly present in oregano (a flowering plant amongst mint family); it is antioxidant, anti inflammatory, anti proliferative, anti mycobacterial.

- ***Octanol: -***

1-Octanol, also known as octan-1-ol, is the organic compound with the molecular formula $CH_3(CH_2)_7OH$. It is a fatty alcohol. Many other isomers are also known generically as octanols. It is use in perfumes and flavorings. It appears as a clear colorless liquid with a penetrating aromatic odor. Insoluble in water and floats on water; it is known to inhibit tremor in essential tremor.

- ***Auraptenol: -***

Auraptenol belongs to coumarins and derivatives class of compounds. Those are polycyclic aromatic compounds containing a 1-benzopyran moiety with a ketone group at the C2 carbon atom (1-benzopyran-2-one) (s)-auraptenol is practically insoluble (in water) and a very weakly acidic compound (based on its pKa). (s)-auraptenol can be found in citrus, which makes (s)-auraptenol a potential biomarker for the consumption of this food product. It has antidepressant-like effects in mice models of depression. In mouse forced swimming test and tail suspension test, two validated models of depression, auraptenol dose-dependently decreased the immobility duration within the dose range of 0.05-0.4 mg/kg. In addition, the antidepressant-like effects of auraptenol was significantly averted by a selective serotonin 5-HT1A receptor antagonist WAY100635 (1 mg/kg).

- ***Octadien: -***

It is a member of the class of compounds known as enones. Enones are compounds containing the enone functional group, with the structure RC(=O)CR'. It is insoluble (in water) and an extremely weak acidic compound (based on its pKa). It has a fruity, grassy, and green taste.

- ***Apigenin: -***

It is a natural flavonoid compound found in many fruits & vegetables serves multiple physiological functions.

Main sources of apigenin: -

It is present in onion, oranges, wheat, tea, grapes, parsley, thyme.

Basic pharmacokinetics of apigenin (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of apigenin: -

It calms the nerves, provides antioxidant effects, prevents & helps the body to fight cancer; it is anti-obesity; neuro-protective, help mood & brain function; reduces cortisol, blood sugar; improves bone, heart & skin health; promotes sleep. It is also anti bacterial, anti viral; reduces blood pressure.

- ***Naringenin: -***

It is bitter colourless flavanone a type of flavonoid, it mainly present in grapes.

Main sources of naringenin: -

It is present in grapes, tomato, cocoa, sour oranges, Greek oregano, beans, thyme etc.

Basic pharmacokinetics of naringenin (based on human intake in natural food products): -

It is readily absorbed through intestinal epithelium by passive diffusion, it gets in to the blood stream by multi-drug resistance-associated protein (Mrp1) or can be transported by active efflux protein carrier P-glycoprotein (P-gp) & Mrp-2 back to the intestine lumen, out of the enterocytes, repeating the cycle. Liver metabolize it via phase 2 conjugation by UDP-glucuronosyl transferase (UGT) & etc.

Basic clinical pharmacology of naringenin: -

It is anti inflammatory, antioxidant, it helps in controlling blood pressure, blood sugar, obesity, metabolic syndromes; it is anti cancer, helpful in curing liver diseases.

- ***Naringin: -***

Naringin is a flavanone-7-O-glycoside between the flavanone naringenin and the disaccharide neohesperidose. The flavonoid naringin occurs naturally in citrus fruits, especially in grapefruit, where naringin is responsible for the fruit's bitter taste. It has antioxidant, anti-carcinogenic and cholesterol lowering activity. It is also an aldose reductase inhibitor which means that it can help to fight retinal disease linked to diabetics.

- ***Luteolin: -***

It is a tetra-hydroxy flavone (flavonoids are polyphenolic compounds); a naturally occurring flavonoid

Main sources of luteolin: -

Celery seeds, thyme, green pepper, fenugreek seeds, broccoli, carrot, orange, basil etc.

Basic pharmacokinetics of luteolin (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of luteolin: -

It is famous for activities like anti oxidant, anti inflammatory, apoptosis (inducing & chemo-preventive activities), reduces free radicals, oxidative stress, reduces tumour cell growth & suppresses metastasis & cancer growth.

- ***Chrysoeriol: -***

Chrysoeriol is a flavone, chemically the 3'-methoxy derivative of luteolin. It showed vaso-relaxant and hypotensive activity in vitro and in vivo in a murine model by intravenous infusion on researches.

- ***Diosmetin: -***

It is a naturally occurring flavone; it is also called astrihydroxy-4methoxy-flavone; it is present in Caucasian vetch, marjoram, citrus fruits, lemon peel, orange, grapes; it is a mono-methoxy-flavone; it is antioxidant, anti-cancer, anti-microbial, estrogenic, anti-inflammatory.

- ***Quercetin: -***

It is a plant flavonol from the flavonoid group of polyphenols; it is bitter in taste.

Main sources of quercetin: -

Red onion, green tea, apples, ginko biloba, grapes etc.

Basic pharmacokinetics of quercetin (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are under research.

Basic clinical pharmacology of quercetin: -

It is good for heart diseases, coronary heart disease, prevents cancer, arthritis, bladder infection, diabetes; it is anti oxidant, anti inflammatory, reduces benign prostatic hyperplasia, cholesterol, blood pressure, asthma, symptoms of rheumatoid arthritis.

- ***Isorhamnetin: -***

Isorhamnetin is the methylated metabolite of quercetin. Quercetin is an important dietary flavonoid with in vitro antioxidant activity. However, it is found in human plasma as conjugates with glucuronic acid, sulfate or methyl groups, with no significant amounts of free quercetin present.

- ***Rutin: -***

It is also called as Rutoside, it is a citrus flavonoid found in many plants including citrus fruits & it is soluble in water & alcohol.

Main sources of rutin: -

It is present in green tea, quince, apple, asparagus, black tea, citrus fruits, grapes, cherries, apricot, noni, leaves of eucalyptus, buck wheat, ginkgo biloba, raisins etc.

Basic pharmacokinetics of rutin (based on human intake in natural food products): -

Its absorption, metabolism & excretion are yet not known & are in research.

Basic clinical pharmacology of rutin: -

It reduces high blood pressure, bleeding, bleeding piles, it strengthens the blood vessels, it reduces risk of cancers due to its anti oxidant & anti free radicals activity, reduces bruise, inflammation, protects heart, brain etc; it is chelator of metal ions.

- ***Ferulic acid: -***

It is a hydroxycinnamic acid, an organic phenolic compound; it is antioxidant & used in skin care products, it reduces spots, wrinkles, it is anti-ageing, anti hypertensive, anti diabetic, helpful in cardiovascular diseases, Alzheimer's etc. It is mainly present in bran, oats, rice, eggplant, citrus, apple seeds etc.

- ***Sinapic acid: -***

It is a small natural hydroxycinnamic acid, it is among phenyl-propanoid family; it is also called as sinapinic acid; it is mainly present in spices, citrus fruits, berry fruits, vegetables, cereals, seeds, oilseed crops; it is antioxidant, anti inflammatory, anti cancer, anti glycemic, neuro-protective, antibacterial, anti-mutagenic.

- ***Malonic acid: -***

Malonic acid (propanedioic acid) is a dicarboxylic acid with structure $CH_2(COOH)_2$. The ionized form of malonic acid, as well as its esters and salts, are known as malonates. Malonic acid is a naturally occurring substance found in some fruits. In citrus, fruits produced in organic farming contain higher levels of malonic acid. It helps in controlling acidity.

- ***Eucalyptol: -***

Eucalyptol is a natural organic compound that is a colorless liquid. It is cyclic ether and a monoterpenoid. It is present in eucalyptus oil, wormwood, rosemary, lime peel oil etc; it is a strong anti-inflammatory, relaxant, anti-tussive remove phlegm.

- ***Bisobolol: -***

It is a natural monocyclic sesquiterpene alcohol. It is colorless viscous oil that is the primary constituent of the essential oil from German chamomile (Matricaria recutita) and Myoporum crassifolium. It is anti-inflammatory properties, best for acne, rashes, rosacea, psoriasis, and similar conditions associated with frequent skin irritations; it protects from sunburn.

- ***Kaempferol: -***

It is a natural flavonol (a type of flavonoid) it is tetra-hydroxy-flavone.

Main sources of kaempferol: -

Fenugreek seeds, green tea, grapes, tomato, broccoli, spinach, raspberries, peaches, green beans, onion, potato etc.

Basic pharmacokinetics of kaempferol (based on human intake in natural food products): -

It is ingested as a glycoside, absorbed in small intestines usually by passive diffusion; it is metabolized in various parts of the body. In small intestine it is metabolized to glucuronide & sulfo-conjugate by intestinal enzymes & it is also metabolized by colon micro-flora (bacteria) which can hydrolyze the glycosides to aglycones or form simple phenolic compounds. It is mainly metabolized in liver to glucurono-conjugated & sulfo-conjugated form. It is mainly excreted in urine.

Basic clinical pharmacology of kaempferol: -

It is anti oxidant, anti inflammatory, anti microbial, anti cancer, cardio protective, neuro microbial, anti diabetes, estrogenic, analgesic, anxiolytic, anti allergic, anti viral etc.

- ***Carotenoid: -***

It is a fat soluble; it is also called as tetraterpenoid; it is an organic pigment produced in plants giving them bright red, yellow, orange etc colour. It helps the plant to absorb light energy for photosynthesis; it protects our body from diseases & maintains health. It is of more than 600 types of which 50 to 60 types are eaten in food by human. It is not made by our body we depend on food source to be eaten.

Main sources of carotenoid: -

Carotenoid is present in olive oil, watermelon, tomato, kale, oranges, olive, carrot, plums, apricots, mango, sweet potato, kale, spinach, coriander, grapes etc.

Basic pharmacokinetics of carotenoid (based on human intake in natural food products): -

It is fat-soluble; It first gets emulsified followed by solubilized in micellar then require bile salts & absorbed in intestine, little is absorbed in stomach; it is excreted in stools (research in on), it is stored in body fats and will convert the stored carotenoid into vitamin A when needed by the body and use it.

Basic clinical pharmacology of carotenoids: -

It is converted into vitamin A in our body, it is essential for vision, immune system, prevents cardio vascular disease, it helps reducing inflammation, cancers risk.

- ***Beta carotene: -***

It is an anti oxidant that converts into vitamin A & plays a very important role in human health; it is responsible for the red, yellow, orange colouration in some fruits & vegetables. It promotes eye health & prevents eye diseases.

Main sources of beta carotene: -

It is present in pumpkin, carrot, sweet potato, dark leafy vegetables, apricot, red & yellow pepper, spinach, kale, grapes etc.

Basic pharmacokinetics of beta carotene (based on human intake in natural food products):

It is absorbed in intestine by passive diffusion & get convert into provitamin A in the presence of bile acids, the intestinal mucosa plays a key role in converting it into provitamin A. it is transported in blood plasma exclusively by lipoproteins. The complete absorption, metabolism & excretion in not known fully. It is stored in fats & liver.

Basic clinical pharmacology of beta carotene: -

It is anti oxidant, reduces risk of lung cancer & promote lung health, reduces free radicals thus prevents cancer & heart disease, diabetes, promotes skin health, improves complexion, hair health, eye health, brain health; reduces pimple, acne & other skin problems.

- ***Flavonols: -***

Flavonols are polyphenols & belong to class of flavonoids; they are colourless molecules that accumulate mainly in the outer & aerial tissues (skin & leaves) of the fruits & vegetables because their biosynthesis is stimulated by light so absent in inner parts of fruits & vegetables. There are more than 7000 flavonoids discovered yet & many more are to be discovered.

Main sources of flavonols: -

It is present in tea, leek, onion, broccoli, kale, berries, grapes, quince, cucumber etc.

Basic pharmacokinetics of flavonols (based on human intake in natural food products): -

Its absorption, metabolism & excretion in natural form are not yet known & are under research. Flavonoids are mostly absorbed in small intestine, after absorption flavonoids conjugates with glucuronic acid or sulfate or methylation may occur; no free flavonoids are found in plasma or urine except catechin; the part of it which

remains undigested is degraded into phenols in colon (large intestines) by microorganisms & absorbed, the absorbed part is further metabolized in liver; it is excreted via urine & bile.

- ***Beta-sitosterol: -***

It is among phytosterols & a main dietary phytosterol found in plants. It is anti cancer, anti inflammatory, it improves urine flow, reduces symptoms of heart diseases, reduces cholesterol, boost immune system, reliefs bronchitis, migraine, asthma, fatigue, rheumatoid arthritis, improve hairs quality, reliefs prostrate problems, improves erectile dysfunctioning, psoriasis, libido.

Main sources of beta-sitosterol: -

Canola oil, avocados, almond, soya bean oil, nuts, vegetable oil, dark chocolate, rice bran oil, wheat germ, corn oil, peanuts, grapes etc.

- ***Daucosterol: -***

Daucosterol (CA2), a steroid saponin that is sitosterol attached to a beta-D-glucopyranosyl residue at position 3 via a glycosidic linkage, it has been isolated from Panax japonicus var. major and Breynia fruticosa. It has a role as a plant metabolite. It is a strong anticancer & was identified as major anticancer principle of the C. adansonii extract. Daucosterol significantly inhibited LNCaP, DU145 and PC3 prostate carcinoma cell growth and proliferation at the optimal concentration of 1 μg/mL. It also significantly increased the number of late apoptotic (DU145) and apoptotic (PC3) cells.

- ***Stigmasterol: -***

It is among unsaturated phytosterol; it maintains the structure & physiology of cell membrane; it reduces LDL & cholesterol, reduces risk of heart diseases, it prevents atherosclerosis.

Main sources of stigmasterol: -

Soybean, calabar bean, rape seed, legumes, nuts, milk, seeds, grape seed oil etc.

- ***Campesterol: -***

It is a phytosterol whose chemical structure is similar to cholesterol, it is phyto-steriod in nature; it reduces cholesterol (reduces absorption of cholesterol in intestine), prevents cancer.

Main sources of campesterol: -

Soybean oil, vegetable oil, banana, cucumber, grapes seed oil, onion, potato, lemon grass etc.

- ***Chlorophyll: -***

The green colour of olive fruit is mainly due to pigments of chlorophyll & yellowish colour due to carotenoid; the presence of chlorophyll-A make the extra virgin olive bluish-green colour & chlorophyll-B make the oil yellowish-green. Its atomic symbol is Mg, & atomic number is 12; its salts are essential in nutrition, required for activity of many enzymes, it is component of both intra & extra cellular fluids.

Main sources of chlorophyll: -

Chlorophyll is present in olive oil, wheatgrass, broccoli, grapes, celery, peas, sprouts, dark leafy vegetables etc.

Basic pharmacokinetics of chlorophyll (based on human intake in natural food products): -

It is absorbed in small intestines but little can be absorbed because it cannot resist long to get digested & is excreted in urine & stools.

Basic clinical pharmacology of chlorophyll: -

Its deficiency causes irritability of nervous system, also causes vasodilation (dilate the blood vessels), tremors, depression, psychotic behavior. It helps the entire body to flush out toxins that can cause diseases, improves heart function, also helps in losing weight, reduces acne & pimples, and also prevents cancers, acts on skin & body healthy.

- ***Acetic acid, formic acid, Citric acid, succinic acid: -***

These acids are present naturally in all types of honey & it prevents honey bee colony (hive) from many mites infection like Varroa jacobsoni, one of the most common and dangerous mites in colonies of honey bee and can cause the death of untreated bee hives in a few years. They have anti bacterial, anti viral & antifungal properties. Succinic acid is a dicarboxylic acid with the chemical formula $(CH_2)_2(CO_2H)_2$. The name derives from Latin succinum, meaning amber.

- ***Malonic acid: -***

Malonic acid, also called Propanedioic Acid; it is a dicarboxylic acid with a chemical formula $C_3H_4O_4$**.** Dicarboxylic acids are organic compounds containing two carboxylic acid functional groups. Dicarboxylic acids generally show the same chemical behavior and reactivity as monocarboxylic acids. Malonic acid is a substance found in some fruits that occurs naturally. Fruits generated in organic farming contain greater concentrations of malonic acid in citrus compared to fruits generated in conventional farming. Malonic acid is also known to be a competitive inhibitor of succinic dehydrogenase, the enzyme responsible for the dehydrogenation of succinate within the Krebs cycle.

- ***Dietary fiber: -***

It is an eatable part of vegetables & fruit; our body cannot digest it just passes the small intestines & colon & excrete in stools; it is of two types 1) soluble fiber 2) insoluble fiber.

Soluble fiber dissolve in water & form a gel like material & helps in controlling blood cholesterol & blood glucose; it is found in apple, carrot, barley, oats, peas, beans watermelon etc.

Insoluble fiber do not dissolve & promotes excretion & increase bulk of the stool thus relief constipation & helps in elimination of toxins also. It is found in wheat flour, beans, cauliflower, potato, green beans, watermelon, beetroot, beet leaves etc.

This is the reason it is helpful in constipation conditions, it can eaten in pregnancy to relief constipation and get other benefits of it also.

Basic pharmacokinetics of dietary fiber (based on human intake in natural food products): -

Soluble fibers get dissolve in water & become a gelatinous substance; do not get digested; it helps to slow the digestion & help the body to absorb vital nutrient from eaten food.

Insoluble fibers do not dissolve in water but remain in fibrous form, and do not get digested; it helps the food pass through the digestive system and increase the bulk of stool & eliminate toxins also.

Basic clinical pharmacology of dietary fiber: -

It helps in slow down the digestive process thus gives a good control in blood glucose, improves insulin sensitivity, reduces risk of diabetes, maintains weight, helpful in obesity, reduces blood pressure, reduces cholesterol, reduces inflammation, reduces risk of heart disease, relieves constipation thus helpful in piles, fistula & other rectal disorders & disease, improves bowel movement thus improves bowel health, slowdowns the digestion thus improves quality of digestion, reduces risk of many types of cancer.

- ***Pectin: -***

Bananas are also a good source of other types of fiber, such as pectin. Some of the pectin in bananas is water-soluble. When bananas ripen, the proportion of water-soluble pectin increases, which is one of the main reasons why bananas turn soft as they age; this pectin is used in medicine making.

- ***Hemicellulose: -***

It is also known as polyose; it is heteropolymer (matrix polysaccharides) non digestible dietary fiber present along with cellulose in almost all terrestrial (grow & live on soil) plant cell walls.

Basic clinical pharmacology of hemicellulose: -

As it is indigestible fiber it reliefs constipation, slow down starch hydrolysis, reduce candida, improves digestion, improves overall health.

- ***Lignin: -***

Lignin is a class of complex organic polymers that form key structural materials in the support tissues of vascular plants and some algae. Lignins are particularly important in the formation of cell walls, especially in wood and bark, because they lend rigidity and do not rot easily.

- ***Cellulose: -***

Cellulose is the main substance found in plant cell walls and helps the plant to remain stiff and strong. Humans cannot digest cellulose, but it is important in the diet as a source of fiber. Cellulose is a long chain of linked sugar molecules that gives wood its remarkable strength. It is helpful in constipation.

- ***Carbohydrate: -***

It is a macronutrient needed by the body, the body receives 4 calories per 1 gram of it; carbohydrates includes sugar, glycogen, starch, dextrin, fiber & cellulose that contain only oxygen, carbon & hydrogen. It is classified in

simple & complex; simple carbs are sugar & complex carbs are fiber & starch which take longer to digest. It is basic source of energy for our body.

Main sources of carbohydrates: -

It is present in watermelon (little), potato, sweet potato, bread, oats, butter, white rice, whole grain rice, pasta, lentils, banana, pineapple, quince, cucumber etc.

Basic pharmacokinetic of carbohydrate (based on human intake in natural food products): -

Its digestion begins in mouth; salivary glands releases saliva & salivary amylase (enzyme) which begins the process of breaking down the polysaccharides (carbohydrates) while chewing the food; now the chewed food bolus is passed in stomach through food pipe (esophagus); gastric juice like HCL, rennin etc & eaten material are churned to form chyme in the stomach; the chyme now is passed little by little down into duodenum, pancreatic amylase are released which break the polysaccharides down into disaccharide (chain of only sugars linked together); now the chyme passes to small intestine, in it enzymes called lactase, sucrase, maltase etc breakdown disaccharides into monosaccharide (single sugar) & absorbed in upper & lower intestines, through villi present in small intestine & send into liver through venous blood present into portal veins, as per bodies need it is releases in the blood stream & pancreas release insulin to use it as source of energy for the body, & extra is stored is converted into glycogen by liver & stored in liver & little is stored in muscles & tissues. Liver can reconverts glycogen in to sources of energy if body lacks for other source of energy, the undigested carbohydrates reaches the large intestine (colon) where it is partly broken down & digested by intestinal bacterias, the remains is excreted in stools.

Clinical pharmacology of carbohydrates: -

Carbohydrates are main sources of body energy, it helps brain, kidney, heart, muscles, central nervous system to function, it also regulates blood glucose, it acts on uses of protein as energy, breakdown of fatty acids & prevent ketosis. If we eat less carbohydrate it may lead to hypoglycemia, ketosis, frequent urination, fatigue, dizziness, headache, constipation, bad breath, dehydration etc.

Excessive intake of carbohydrates may lead to vascular disease, atherosclerosis (leads to narrowing of arteries, stroke, diabetes, obesity, fatty liver, blood pressure etc.

- ***Cobalt: -***

It is a mineral, its symbol is Co & atomic no. is 27; it is a component of vitamin B12, it is present in earth crust, soil etc we get it from plant also.

Main sources of cobalt: -

Fish, nuts, green leafy vegetables, broccoli, spinach, oats etc.

Basic pharmacokinetics of cobalt (based on human intake in natural food products): -

It is absorbed in intestine, in small doses it is almost completely absorbed but in large doses it is poorly absorbed. Amino acids reduce its absorption & iron deficiency increases it absorption. It is stored in liver where vitamin B12 is stored & it is primarily excreted in urine & little in stools.

Basic clinical pharmacology of cobalt: -

It improves over health, acts in RBC & heamoglobin formation, maintain neurological health, it acts on absorption & process of vitamin B12, helpful in anaemia, infection, repairs myelin sheath (covering of nerves), protect nerve cells.

- ***Iodine: -***

Iodine is a mineral naturally found in many food products & is needed for the production of thyroid hormone; the body cannot make iodine so it is essential for the body through food sources; iodine deficiency causes goiters (thyroid gland disease), hypothyroidism.

Main sources of iodine: -

Cod liver oil, egg, shrimp, dairy products, seaweed, prunes, iodized salt, tuna, cucumber etc.

Basic pharmacokinetics of iodine (based on human intake in natural food products): -

It is absorbed in intestine; dietary iodine is converted into iodide ion before absorption & is totally absorbed from food and water, and is taken up by thyroid gland & excreted through kidney in urine. It is stored in thyroid gland.

Basic clinical pharmacology of iodine: -

Iodine helps convert TSH (thyroid stimulating hormone) to convert T4 into T3 and body uses this hormone in all vital functions of the body. This conversion takes place in liver, heart, muscles, nerves, gut & brain. And deficiency

of it can cause goiters (enlargement of thyroid gland), hypothyroidism & cause all sign & symptoms of thyroid disease.

- ***Fluoride: -***

It is a naturally occurring mineral found in all sources of water & helps preventing cavities in teeth, makes enamel strong, prevents tooth decay, prevent teeth from acid attack. Makes immune system stronger, Excessive of it is injurious to health.

Main sources of natural fluoride: -

Tea, grapes, potato, coffee, shellfish, shrimps, water, rain water etc.

Basic pharmacokinetics of fluoride (based on human intake in natural food products): -

Much is not known about its absorption & metabolism. It is absorbed in stomach & small intestines, as it gets absorbed it rapidly enters mineralized tissues like teeth & bones; it do not get accumulated in soft tissues. Calcium & magnesium reduce its absorption.

- ***Choline: -***

It is water soluble vitamin & essential nutrient, it is a constituent of lecithin; it helps in many functions of the body.

Main sources of choline: -

It is present in watermelon, egg, peanut, fish, dairy products, wheat, beetroot, spinach, beans, whole grains, grapes etc.

Basic pharmacokinetics of choline (based on human intake in natural food products): -

Choline is mostly present in food in free form; it is absorbed in small intestine via transporter proteins & metabolized in liver; excessive choline is not stored but converted into phospholipids; it is changed into Trimethylamine in liver & is excreted in urine.

Basic clinical pharmacology of choline: -

It helps the nerves to develop signals. Our body makes some amount of choline, but should be consumed to avoid deficiency; it helps liver function, brain development, muscles movement, cell messenger system, DNA synthesis, nervous system, gall bladder function; it can be taken in pregnancy because it prevents neural tube defect. It aids in fats & cholesterol metabolism & prevent excessive fat building in liver.

- ***Vitamin A: -***

It is a fat soluble vitamin; it is group of unsaturated organic compound that includes retinol, retinal, retinoic acid & several provitamin A carotenoid. There are 2 types of vitamin A, 1) Vitamin A: - found in meat, poultry, fish & dairy products; 2) Provitamin A: - found in fruits, vegetables, plants; beta carotene is common type of provitamin A; it is an antioxidant, reduces wrinkles & repairs the skin damages; it is available in the market as tretinoin in tablets & creams to heal acne.

Main sources of vitamin A: -

It is present in watermelon, fish oil, carrot, green leafy vegetables, citrus fruit, sweet potato, spinach, kale, quince, pumpkin, grapes etc.

Basic pharmacokinetic of vitamin A (based on human intake in natural food products): -

It is absorbed in jejunum mainly, little through skin; metabolism is in liver & excreted in urine & stools, it is conjugated with glucuronic acid & then changed into retinal & retinoic acid; retinoic acid is excreted in stool, mainly. It is stored primarily as palmitate in Kupffer's cells of liver, normal adult liver stores sufficient amount of it which is enough for 2 years for the body, little is stored in kidneys, lungs, adrenal glands, fats, retina; it is excreted in urine & stools.

Clinical pharmacology of vitamin A: -

it is needed by the body for vision and maintains eye health speacially retina; it prevents night blindness; it helps in normal reproduction of cells thus prevents cancer; it is required for proper growth & development of embryo throughout the pregnancy period, it is good for skin, supports immune function; helps the heart, kidneys & lungs to work properly.

- ***Vitamin K: -***

It is a fat soluble vitamin; it is essential for normal blood clotting; it occurs naturally in two forms, vitamin K1 (phylloquinone) which is widely distributed in plants; it is present in it; Leafy vegetables are good sources of K1; vitamin K2 (menaquinones) is synthesized in alimentary tract by bacteria (Escherichia coli & other bacteria).

Main sources of vitamin K1: -

It is present in olive oil & also present in green leafy vegetables (spinach, kale etc) cauliflower, cabbage, broccoli, sprout, fish, liver, meat, egg, cereals, pumpkin, grapes etc.

Basic pharmacokinetics of vitamin k (based on human intake in natural food products): -

It is absorbed in small intestine, bile is required for it absorption & stored in fatty tissues & liver; it is excreted 40% to 50% in stools & 30% to 40% in urine.

Basic clinical pharmacology of vitamin K: -

It acts on synthesis of certain proteins that are prerequisites (necessary) of blood coagulation (means act on stop bleeding) & body also needs it to control the binding of calcium in bones & other tissues. Deficiency of it makes bones weaker, calcification of arteries & other tissues thus take care of bones, joints & heart; it reduces tumour growth & is helpful in cancers.

- ***Vitamin E: -***

It is fat soluble vitamin; it is a group of eight fat soluble compounds that includes four tocopherols & four tocotrienols.

Main sources of vitamin E: -

It is present in olive oil, almonds, cereals, wheat germ, sunflower oil, corn oil, soybean oil, peanuts, green leafy vegetables, pumpkin, grapes etc.

Basic pharmacokinetics of vitamin E (based on human intake in natural food products): -

It is absorbed in small intestines & metabolized in liver & distributed through lymphatic system & stored in fat droplets of adipose tissue cells; it is mainly excreted in stool, little in urine & through skin.

Basic clinical pharmacology of vitamin E: -

It prevents coronary heart disease, supports immune system, prevent inflammation, promotes eye health, lowers the risk of cancer; It is a powerful anti-oxidant thus reduces UV damage of skin, nourishes & protects the skin when applied on face; also promotes hair growth.

- ***Vitamin C: -***

It is also called as Ascorbic acid; it is an essential water soluble vitamin, very much needed by the body for many functions & absorption etc.

Main sources of vitamin C: -

It is present in watermelon, citrus fruit, broccoli, cauliflower, sprouts, capsicums, papaya, strawberries, spinach, green & red chilies, cabbage, leafy vegetables, tomato, cereals, quince, cucumber etc.

Basic pharmacokinetic of vitamin C (based on human intake in natural food products): -

It does not need to undergo digestion, 80 to 90% of it eaten is absorbed by intestine cell border by active transport & passive diffusion & through ion channels it enters the plasma via capillaries. It is very little stored in adrenal glands, pituitary gland, brain, eyes, ovaries, testes, liver, spleen, heart, kidneys, lungs, pancreas & muscles. All together body can store 5 grams of it & we need 200mg/day in order to maintain its normal level & uses, but old, disease person, smokers & alcoholic need more daily value. It is excreted in urine in the form of dehydroascorbic acid changed by liver & kidneys both, but unused vitamin C is excreted intact.

Basic clinical pharmacology of vitamin C: -

It prevent cough & cold, repairs tissue, acts as an enzyme for curtain neurotransmitter, important for immune function, it is a powerful antioxidant (donates electron to various enzymatic & non-enzymatic reactions); body prepares collagen with the help of vitamin c; it is also helpful in Alzheimer's, dementia, acts on iron absorption, it protects the body from oxidative damages, reduces stiffness of arteries, reduces tendency of platelets to clump each other, improves nitric oxide activity (dilatation of blood vessels) thus prevents high blood pressure & heart disease, also prevent eye disease, reduces risk of cataract, prevents the lining of lungs & prevents lung disease, it is a natural antihistamine (anti allergy), eliminates toxins from the body. Deficiency of it causes Scurvy disease (brown spots on skin occurs, swelling of gums, bleeding from all mucous membrane, spots are more on thighs & legs, the person looks pale, feel depressed, cannot move, loss of teeth, suppurative wounds occur.

- ***Vitamin B1 (Thiamin): -***

It is called as Thiamin also; it is a water soluble vitamin, it belongs to B-complex family, it is an essential micro nutrient which cannot be made by our body.

Main sources of vitamin B1: -

It is present in watermelon, spinach, legumes, banana, quince, wheat germ, liver, egg, meat, dairy products, nuts, peas, fruits, vegetables, cereals, rice, breads, oats, cucumber etc.

Basic pharmacokinetic of vitamin B1 (based on human intake in natural food products): -

Intestinal phosphatases hydrolyze thiamin to make it free & absorbed in duodenum, jejunum mainly through active transport in nutritional doses & passive diffusion in pharmacological doses, very little is known about its absorption; it is metabolized in liver; it is excreted in urine & stored little in liver, heart, kidney, brain, muscles.

Clinical pharmacology of vitamin B1: -

It is needed for metabolism of glucose, amino acids (proteins), lipids (fats) etc; every cell of the body require it to form ATP (adenosine triphosphate) as a fuel for energy, also it enables the body to use carbohydrates as sources of energy; also nerve cells, heart cells, muscles cell require it to function normally; its deficiency causes beri-beri heart disease, weight loss, confusion, malaise, optic neuropathy, irritability, memory loss, delirium, muscles weakness, loss of appetite, tingling sensation in arms & legs, blurry vision, nausea, vomiting, reduce refluxes, shortness of breath etc; it is helpful to immune system; excessive intake of carbohydrates, protein, glucose (specially in body builders, athletes etc) increases the need of vitamin B1.

- ***Vitamin B2: -***

It is also called as Riboflavin, it is a water soluble vitamin, it is an essential micro nutrient, it helps many systems of the body; it is not synthesized in human body.

Main sources of vitamin B2: -

It is present in watermelon, liver, milk, dairy products, nuts, egg, fish, leafy vegetables, almonds, mushroom, lean meat and quince, cucumber.

Basic pharmacokinetic of vitamin B2 (based on human intake in natural food products): -

It is phosphorylated in the intestinal mucosa during absorption; mainly absorbed in upper gastrointestinal tract; the body absorbs little from a single dose beyond of 27mg; when excessive amount is eaten it is not absorbed; very little is known about its absorption. The conversion of it into its coenzymes takes place mainly in cells of small intestines, heart, liver, kidneys & throughout the body in many cells; it is excreted in urine & stored little in liver, heart, kidneys & in tissues of the body.

Basic clinical pharmacology of vitamin B2: -

It is needed by the body to keep skin, eyes, nerves, red blood cells healthy, it also helps adrenal gland, nerve cells, heart, brain to function; it also act in metabolism of food, amino acids (protein), fats, helps to convert carbohydrate into energy (Adenosine triphosphate formation- the energy body runs on). It plays an important role in functioning of mitochondria.

Its deficiency is called as Ariboflavinosis & causes weakness, throat swelling, soreness of mouth & tongue, cracks on skin, dermatitis, anemia, weak vision, itching & irritation in eyes, migraine.

- ***Vitamin B3: -***

It is called as Niacin or Nicotinic acid; it is in 2 forms niacin & nicotinamide acid; it is water soluble vitamin; it is an essential micro nutrient; it plays a role in over 200 enzymatic reactions in the body; It is produced in the body in small amount from tryptophan which is found in protein containing food & sufficient amount of magnesium, vitamin B6 & B2 (are needed to produce it).

Main sources of vitamin B3: -

It is present in watermelon, green peas, peanuts, mushroom, avocados, meat, egg, fish, milk, cereal, green vegetables, liver, chicken, coffee, potato, corn, pumpkin, tomato, almonds, spinach, enriched bread, carrots, quince, cucumber etc.

Basic pharmacokinetic of vitamin B3 (based on human intake in natural food products): -

If eaten in natural form it is absorbed in stomach & small intestines by the process of sodium-dependent carrier-mediated diffusion in 5 to 20 minutes; if taken in therapeutic doses get absorbed by passive diffusion in small intestines. Its uptake in brain requires energy, in kidneys & red blood cells requires a carrier. It is metabolized in

liver in 2 ways either is conjugated with glycine or niacin is form into nicotinamide; it is stored little in liver unbounded to enzymes. It is excreted in urine.

Basic clinical pharmacology of vitamin B3: -

It regulates lipid level in the body; it acts on carbohydrate to form energy sources for the body, it ease arthritis, boost brain function, every part of body needs it to function properly, it helps convert food into energy by aiding enzymes & cellular metabolism, it acts as an antioxidant. It prevents heart disease. Deficiency of it causes pellagra, high blood cholesterol, memory loss, fatigue, depression, diarrhea, headache, skin problems, lesion in mouth, tiredness etc.

- ***Vitamin B5 (pantothenic acid): -***

It is also called as pantothenic acid, it is water soluble vitamin, it is a micro nutrient, it is necessary for making blood cells; acts to convert eaten proteins, carbohydrate, fats into energy; it is a component of coenzyme A; it is used in synthesis of coenzyme A. (coenzyme A acts on transport of carbon atoms within the cell).

Main sources of vitamin B5: -

It is present in watermelon, quince, meat, chicken, liver, kidney, fish, grains, milk, dairy products, legumes, pumpkin, grapes etc.

Basic pharmacokinetic of vitamin B5 (based on human intake in natural food products): -

It is converted into free form by intestinal enzymes & in nutritional doses it is absorbed in intestinal cells via sodium dependent active transport system in jejunum & pharmacological doses are absorbed by passive diffusion; after absorption the free form of it is now transported to erythrocytes via plasma, in cells pantothenic acid is converted into CoA, all the body tissues can convert it into CoA & ACP (acyl carrier protein), after these two complete their jobs they are degraded to form free pantothenic acid & other metabolites. It is excreted in urine & stools & little in exhaled in carbon dioxide.

Basic clinical pharmacology of vitamin B5: -

It promotes skin, hair & eyes health, proper functioning of nervous system & liver, formation of red blood cells, making of adrenal hormones, sex hormones; it is very helpful in constipation, rheumatoid arthritis, acne, allergies, asthma, baldness, colitis etc.

Its deficiency causes fatigue, nausea, vomiting, irritability, neurological weakness, numbness, abdominal cramps, sleep disturbances, hypoglycemia etc.

- ***Vitamin B6: -***

It is also called as pyridoxine; it is involved in many aspects of macronutrients metabolism; it is present in many food products naturally.

Main sources of vitamin B6: -

It is present in watermelon, quince, chicken, bread, egg, vegetable, soyabean, whole grain cereals, brown rice, fish, legumes, beef, nuts, beans, liver, citrus fruits, starchy vegetables, potato, cucumber etc.

Basic pharmacokinetic of vitamin B6 (based on human intake in natural food products): -

It is absorbed in small intestines, but before absorption a phosphate group has to be removed making vitamin B 6 in free form & absorbed by passive transport, now reaches liver via portal vein, in liver to get metabolized & flown into the blood stream it is bound with albumin & some are taken up by red blood cells, once getting in blood it can function & promote health & it is excreted mainly in urine & little is excreted in stools, it is very little stored in tissues, muscle tissues, liver, brain, kidneys, spleen.

Basic clinical pharmacology of vitamin B6: -

It is needed for proper development & function of brain in children; it is needed for neurotransmitter, histamine, haemoglobin synthesis & function. It serves as coenzyme (cofactor) for many reactions in the body, it is the master vitamin for processing amino acids & some hormones, it is needed by the body to prepare serotonin, melatonin & dopamine, it is better to intake it during treatment of tuberculosis. It supports adrenal glands to function; it acts as a coenzyme in the breakdown & utilization of fats, carbohydrates, protein, it is important for immune system, it helps in treatment of nerve compression like carpal tunnel syndrome, premenstrual syndrome, depression, arthritis, high homocysteine level, diabetes, asthma, kidney stones etc.

Its deficiency causes seborrheic dermatitis (eruption on skin), atrophic glossitis with ulceration, conjunctivitis, neuropathy, anaemia etc.

- ***Folate (vitamin B9): -***

Folate is an essential micro nutrient, it is a natural form of vitamin B9, it serves many important functions of the body, it plays an important role in cell growth & formation of DNA, RNA & other genetic material & helps in treating many diseases; it name is derived from Latin word Folium, which means leaf, leafy vegetables have it in good amount; Folic acid is a synthetic form of vitamin B9.

Main sources of folate: -

It is present in watermelon, quince, dark green leafy vegetables, fruits, nuts, beans, dates, seafood, egg, dairy products, meat, chicken, legumes, beetroot, citrus fruits, broccoli, spinach, cereals, cucumber etc.

Basic pharmacokinetic of folate (based on human intake in natural food products): -

Its absorption is complicated because folate present in food are of many different forms, some of which cannot be absorbed until broken down by intestinal enzymes; it is not absorbed more than 50%; dietary folate contains glutamate that need to separate it from glutamate before absorption starts; It is absorbed in duodenum & jejunum, after absorption it is converted into tetrahydrofolate (the active form of folate), than a methyl group is added to it to form methyltetrahydrofolate; now the body uses it for various functions & metabolism; the body can store folate 20-70mg in liver which is enough for 3 -6 months for the body; it gets excreted in urine & little in stools & bile.

Basic clinical pharmacology of folate: -

It is needed by the body to make DNA, RNA & other genetic material; it prevents many disease & conditions like anaemia, stroke, cardiac diseases, cancers, neurological diseases, macular degeneration (eye disease), palpitation, sores in mouth & tongue, hair fall, graying of hair. It is important in fertilization in male & female, essential during pregnancy to prevent neural tube defect in embryo (it is needed more), it protect us from free radicals & oxidation thus prevent cancers, it is essential in red blood cells formation, reduces high levels of homocysteine.
Its deficiency may cause anaemia, tiredness, palpitation, breathlessness, hairfall, neural tube defect in baby during pregnancy etc.

- ***Potassium: -***

It is a mineral with symbol K & atomic number 19, it is an essential mineral which body cannot prepare; it is necessary for heart, kidney & other organs to function, its low level in body is called as hypokalemia & high level is called as hyperkalemia; it is mostly present inside the cells (intracellular); normal blood range is 3.5 to 5.0 milli equivalents per/liter (mEq/L).

Main sources of potassium: -

Potassium is naturally present in banana, orange, dates, raisin, broccoli, milk, chicken, sweet potato, pumpkin, spinach, watermelon, coconut water, white & black beans, potato, dried apricot, beetroot, pomegranate, almond, quince, cucumber etc.

Basic pharmacokinetics of potassium (bases on human intake in natural food products): -

It is absorbed in small intestines by passive diffusion; it is stored mostly inside the cell, little in liver, bones & red blood cells. 80 to 90% potassium is excreted in urine & 5 to 20% is excreted in stools, sweat.

Basic clinical pharmacology of potassium: -

It is a mineral belongs to electrolytes of the body; it conducts electrical impulses throughout the body & assists blood pressure, normal water balance, muscle contraction, nerves impulse, digestion, heart rhythm, maintain pH balance. It is not produced in our body so we need to consume it through eating; Kidneys maintain normal level of it in the body by excreting excessive amount of it in urine or reabsorb it if the amount is less in the body so that the body may reuse it. Its deficiency may cause weakness, low blood pressure, constipation, nausea, vomiting etc.
Its normal amount in body keeps blood pressure normal; water balance in body normal; prevents heart disease, stroke, osteoporosis, kidney stone etc.

- ***Sodium: -***

Here we are learning natural sodium, its symbol is Na & atomic no. 11; it is not produced in the body we need to take it in food sources; it is an important & essential mineral on which our body functions; it regulates blood pressure, blood volume etc.

Main sources of sodium: -

Excessive intake of sodium should be avoided; cucumber has very less amount of sodium; vegetables & fruits have less sodium in them which is good for the body. It is present in beans, meat, fish, chicken, chilli, bread, rolls, milk, celery, beetroot etc.

Basic pharmacokinetic of sodium (based on human intake in natural food products): -

It is absorbed in ileum by active sodium transport because it is impermeable & in jejunum absorption takes place via mediated active transport & depends on levels of water, bicarbonate, glucose, amino acids etc; its absorption plays an important role in the absorption of chloride, amino acids, glucose & water; similar mechanism are involved in the reabsorption of it in kidneys when its level in the body falls. It is excreted mainly in urine, little in sweat & stools. It is stores in bones & dissolved in various body fluids.

Basic clinical pharmacology of sodium: -

It is amongst the essential electrolyte within the body, it remains in extracellular fluid (outside the cell) mainly, it carries electrical charges within the body, kidney maintain its normal level in the body, normal level is 135-145 milli-equivalent per liter (mEq/L), it is not produce in the body, it acts on muscles contraction, nerve cells, regulates blood pressure, blood volume; it takes part in every function of the body mostly, its low level in body is called as hyponatremia, it is found more in older aged, kidney disease, heart disease, hospitalized patient, this condition may cause brain edema, low blood pressure, fatigue, tiredness etc; its high level in the body is called as hypernatremia may cause increase in blood pressure, thirst, confusion, muscle twitching or spasm, seizures, weakness, nausea, loss of appetite, swelling in body etc.

Basic clinical pharmacology of flavonols: -

All types of flavonols are anti oxidant, anti inflammatory, anti cancer, reduce oxidative stress, maintains heart health, helpful in asthma, stroke, helps in regulating cellular signaling etc.

- ***Calcium: -***

It is natural essential mineral for the body, it is among the electrolytes of the body; its symbol is Ca & atomic no. 20.

Main sources of calcium: -

It is present in watermelon, quince, milk, banana, cheese, green leafy vegetables, soya beans, nuts, fish, meat, egg, bread, flour, yogurt, almonds, kale, soybean, spinach, cucumber etc.

Basic pharmacokinetics of calcium (based on human intake in natural food products): -

Calcium is absorbed in duodenum & upper jejunum (when calcium intake is low) by transcellular active transport process, this depends on action of calcitriol & intestinal vitamin D receptors & when calcium intake is high, absorbed by paracellular passive process throughout the length of small intestine by 3 major steps, entry across the brush border, intracellular diffusion via calcium-binding protein & extrusion; Vitamin D is necessary for absorption of calcium, also vitamin C, E, k, magnesium & exercise increases the absorption of calcium. Also the level of calcium is regulated by calcitonin released by thyroid gland it reduces calcium level in blood when it is excessive & increases the excretion of calcium via kidneys; Parathyroid hormones (PTH) released by parathyroid gland increases the blood level of calcium when body need it or calcium is less in blood & promotes reabsorption of it in kidneys (calcitonin & PTH both have opposite function). Intestines can absorb 500 to 600 mg of calcium at a time; it is mostly stored in bone tissues & teeth & excreted in stool & sweat & little in urine depended upon the level of it in blood. Also estrogen act on transport of blood calcium in bones thus women mostly suffer from osteoporosis after menopause.

Basic clinical pharmacology of calcium: -

Calcium acts on bone health, communication between brain & other parts of the body, muscles contraction, blood clotting; it is a co-factor for many enzymes, it relaxes the smooth muscles & blood vessels; it maintains heart rhythm, muscles function; it is more needed in childhood & deficiency of it in childhood may cause convulsions (seizure); Excessive level of it in blood is called as hypercalcemia & may lead to kidney stone formation, heart attack, stroke, loss of appetite, excessive urination, memory loss etc; its low level in blood is called as hypocalcemia & may lead to cramps in the body, weak bones, weak teeth, numbness, tingling etc.

Contraindication: -

Sarcoidosis, excessive level of calcium in blood, very severe constipation, kidney stones, increased activity of parathyroid gland etc. Hypersensitivity of calcium, severe cardiac diseases, hypercalcemia, hypercalciuria, severe kidney stones etc.

- ***Iron: -***

It is an essential mineral for our body; its symbol is Fe & atomic no. 26; it is an important component of heamoglobin (heamoglobin binds oxygen in lungs & supply it to whole body, it is oxygen carrier).

Main sources of iron: -

It is present in watermelon, quince, meat, dates, spinach, egg, nuts, dark leafy green vegetables, broccoli, pumpkin seeds, chicken, legumes, fish, banana, cabbage, kidney, almonds, cucumber etc.

Meat is the best source of iron, it provides Fe+2 directly which can be transported from intestine to blood steam through Fe+2 transporter ferroportin (this binds with transferring & delivered into tissues).

Basic pharmacokinetics of iron (based on human intake in natural food products): -

The absorption of iron is not known fully; about only 10% of iron taken in food is absorbed; it is absorbed in duodenum & upper jejunum mainly & at the end part of ileum; low pH is needed for its absorption, after absorption it get bind to transferring (each transferring can carry 2 atoms of iron); ceruloplasmin (protein) also helps in binding of iron; Hepcidin a hormone produced by liver is released when iron stores are full & inhibits iron transport & binding, thus reduces the absorption of iron; vitamin C & copper enhances iron absorption.

Storage of iron: -

Iron is stored in liver (in hepatocytes & kupffer's cells) kupffer's cells play an important role in recycling body iron, they ingest aged RBC liberate iron for it & reuse by breaking down heamoglobin. Little iron is stored in liver, heart, & kidneys in form of ferritin also little in bone marrow, spleen.

Excretion of iron: -

The body does not possess a physiological mechanism for regularly eliminating iron from the body because most of it is recycled by liver cells; iron is lost within cells, from skin & interior surface of the body (intestines, urine, breathe).

Basic clinical pharmacology of iron: -

It is an important component of Haemoglobin (heamoglobin bind oxygen in lungs & supply it to whole body); iron is beneficial for nails, hair, skin etc; it acts on blood production, its deficiency causes Anaemia (low haemoglobin level in blood) (this causes reduced in oxygen carrying capacity & supply of it); most of the iron is present in haemoglobin, it consist of one heme (iron), one protein chain (globin) this allows it to bind & load oxygen from the lungs & supply it to whole body.

Unbounded or free iron is highly destructive & dangerous it can trigger free radical activity which can cause cell death & destroy DNA.

- ***Copper: -***

It is an essential micronutrient mineral; its symbol is Cu & atomic no. 29; there are lot of health benefits of it; it is needed in little amount in the body.

Main sources of copper: -

It is present in watermelon, quince, spirulina (water-plant), nuts, seeds, lobster, leafy green vegetables, guava, grapes, green olive, kiwi, mango, pineapple, pomegranate, egg etc.

Basic pharmacokinetics of copper (based on human intake in natural food products): -

It is absorbed 30 to 50%; it is absorbed easily than other minerals, its absorption depends on the copper present in the body, when the intake of it is less, absorption is increased & when intake is more absorption is less, it is mainly absorbed in small intestines & little in stomach via carrier-mediated process; its absorption is influenced by amino acids, vitamin C & other dietary factors. After absorption it is bound primarily to albumin, peptide & amino acids & transported to liver. Copper is secreted into plasma as a complex with ceruloplasmin. It is mainly stored in liver little in brain, heart & kidneys; it is excreted mainly in bile & little in urine.

Basic clinical pharmacology of copper: -

Together with iron it enables the body to form RBC; it helps to maintain health of bones, blood vessels, nerves & immune system; it also acts on iron absorption, protein metabolism, growth of body, it acts also on development of brain, heart & other organ; it is needed by the body for making ATP, collagen. Excessive of it may cause Wilson's disease.

Deficiency of copper: -

It is very rare; but may cause cardiovascular disease, genetic defects, inflammation of optic nerve etc.

- ***Selenium: -***

It is an essential trace mineral, it is micro nutrient helpful to our body; its symbol is Se & atomic no. 34.

Main sources of selenium: -

It is present in watermelon, fish, nuts, beef, chicken, mushroom, egg, grains, garlic, grapes etc.

Basic pharmacokinetics of selenium (based on human intake in natural food products): -

It is mainly absorbed in duodenum & proximal jejunum by active transport process; Dietary selenium is in 2 forms organic (selenoimethionine) it is 90% absorbed & inorganic (selenite) it is 50% absorbed; after absorption it is send in liver via portal veins, liver turns it into selenite & then is bound with selenoproteins & send into blood stream, gets in RBC, muscles, tissues etc; it is not distributed evenly in the body, liver has more of it; Vitamin E & other vitamins increases its absorption & both work as an anti-oxidant. Natural selenium remains in the body for less than 24 hours; it is stored in amino acid in skeletal muscles, little in liver, kidneys & pancreas; it is primarily excreted in urine, stool & expired in air via lungs very little in sweat & semen.

Basic clinical pharmacology of selenium: -

It is important for many body functions, immune system, fertility (both male & female); it contributes in thyroid hormone metabolism, DNA synthesis; it protects the body from oxidative damages & infection, it is found in tissues, skeletal muscles; it helps testies & seminal vesicles in their function; it reduces the risk of miscarriages, liver disease, cancer, asthma, cardio vascular disease; deficiency of it causes pain in muscles & joints, weaken the hair, nails, white spots on nails are found etc.

- ***Magnesium: -***

It is an important essential mineral; its symbol is Mg & atomic no. 12; it is a co-factor for more than 300 enzymes that regulates functions in the body. Its normal range in blood is 0.75 to 0.95 millimoles (mmol)/L.

Main sources of magnesium: -

It is present in watermelon, quince, spinach, meat, egg, nuts, dark leafy green vegetables, broccoli, pumpkin seeds, dates, chicken, fish, legumes, cucumber etc.

Basic pharmacokinetics of magnesium (based on human intake in natural food products): -

It is absorbed about 20 to 50% only; it is absorbed about 40% in distal intestine when the level of it is low via passive paracellular transport & about 5% in descending colon when the level of it is high via active transcellular transport. Vitamin D increases its absorption & also acts on its excretion in urine. It is excreted in urine & stool; it is stored in bones.

Basic clinical pharmacology of magnesium: -

It is a co-factor for more than 300 enzymes that regulates functions in the body. It act on protein synthesis, muscles & nerve function, blood glucose, control blood pressure, it is required for energy production, bone development, synthesis of DNA & RNA. It also plays a role in active transport of calcium & potassium ions, muscles contraction, normal heart rhythm etc.

- ***Phosphorus: -***

It is an essential mineral; its symbol is P & atomic no. 15, it is needed for many parts & functions of the body.

Main sources of phosphorus: -

It is present in watermelon, quince, meat, nuts, beans, fish, chicken, dairy products, soy, grains, lentils, cucumber etc.

Basic pharmacokinetics of phosphorus (based on human intake in natural food products): -

It is absorbed 70-85%, it is absorbed 30% in duodenum, 20% in jejunum, 35% in ileum; it is absorbed in inorganic phosphate form by 2 separate process first when the phosphorus intake is high mainly after meals by paracellular sodium independent passive diffusion pathway & second is transcellular sodium dependant carrier-mediated pathway this falls under the control of vitamin D & etc. When calcium level is too high in the body phosphorus is less absorbed, optimum calcium : phosphorus ratio is helpful in its absorption (excess of anyone decreases the absorption of both). It is stored in bones 85% & rest in tissues; it is excreted 80% in urine & rest in stools (excretion of it is a regulatory action of parathyroid hormone (PTH), vitamin D, and fibroblast).

Basic clinical pharmacology of phosphorus: -

It is present in nature combined with oxygen as phosphate. It acts on growth of teeth, bones, repairs of cells & tissues. It plays an important role in metabolism of carbohydrate, fats, protein & ATP. It works with B-complex vitamins & helps kidney function, muscles contraction, normal heart beats, nerve impulse etc.

- ***Zinc: -***

It is a trace mineral; symbol is Zn & atomic no. 30; it is necessary for human body as it plays vital role in health.

Main sources of zinc: -

It is present in watermelon, quince, meat, fish, legumes, beans, egg, dairy products, seeds, nuts, whole grains, cucumber etc.

Basic pharmacokinetics of zinc (based on human intake in natural food products): -

It is absorbed 20 to 40%, its absorption depends on its concentration & is absorbed in whole intestines (jejunum has high rate of its absorption) via carrier-mediated mechanism, it is released from food as free ions during digestion. Zinc from animal sources is easily absorbed comparing to plants sources. It is present in bile & pancreatic juices which is released in duodenum & is reused by the body this is called as endogenous zinc & zinc present is food sources is called as exogenous zinc. Its absorption depends on 2 proteins- Albumin & metallophinonein. Albumin enables zinc to be transported from plasma into enterocytes. It is stored in muscles, bones mainly & little in prostate, liver, kidneys, skin, brain, lungs, heart & pancreas. It is excreted in stools 80% & rest in urine & sweat. Metallophinonein binds to zinc to make it unavailable & excrete it in stools when zinc is excess in the body, & production of metallophinonein is reduced when zinc is less in the body to make zinc available for the body.

Basic clinical pharmacology of zinc: -

It is necessary for immune system, prevents skin diseases, heal skin diseases, helps stimulate activity of at least 100 different enzymes in the body; it is required in little amount in the body, but children, pregnant & old aged need it more. It promotes growth in children, synthesize DNA & acts on wound healing, it is best in treating initial diarrhea & cold cough. It improves learning, memory, fertility etc. It heals acne, attention deficit hyper activity disorder (ADHD), osteoporosis, pneumonia etc.

- ***Manganese: -***

It is an essential mineral & micro nutrient, needed by the body for proper health. Its symbol is Mn & atomic no. 25.

Main sources of manganese: -

It is present in watermelon, nuts, beans, legumes, brown rice, leafy green vegetables, pineapple, beetroot etc.

Basic pharmacokinetics of manganese (based on human intake in natural food products): -

It is absorbed 40%, it is absorbed more in women than men; if intake of it is more, than absorption is less & if intake is less, absorption is more; its absorption takes place in small intestines, after absorption it is bounded to blood protein transferring & transmanganin & transport via blood stream to tissues; it is absorbed by inhalation & dermal (skin) also; it crosses brain blood barrier. It is stored in bones, liver, kidney, pancreas; it is excreted mainly in bile & stools, little in urine & sweating; unused manganese is transported to liver for excretion & excreted via bile mainly.

Basic clinical pharmacology of manganese: -

It is needed for proper health of skin, bones, cartilage etc; it helps in glucose tolerance, regulates blood sugar, reduces inflammation, reduces premenstrual cramps, it also aids in formation of connective tissues, bones, sex hormones, blood clotting, metabolism of carbohydrates & fats; it facilitates calcium absorption.

- ***Glucose: -***

It is among simple type of natural sugar present in fruits & vegetables; it is a source of energy for our body & related to many function & digestion.

- ***Sugar (fructose): -***

Sugar present in beetroot is fructose; (but diabetic patients should not eat much of it).

Main sources of fructose: -

It is present in watermelon, honey, banana, apple, mango, cherry, strawberry, orange, kiwi, pears, pomegranate, apricots, carrots, yogurt, bread, lemon, lime, green beans, beetroot etc.

Basic pharmacokinetics of fructose (based on human intake in natural fruit & food products): -

Fructose digestion begins in the small intestine (more in upper jejunum) via active transport or facilitated transport (not known properly). Our body cannot absorb intact polysaccharide molecules. Therefore, if fructose is present in the form of sucrose, sucrase, an enzyme, must first break up sucrose into separate glucose and fructose components. Single fructose molecules then enter the lining of the small intestine through a special channel and exit out the other side into the bloodstream, once in the bloodstream, fructose travels with all other absorbed nutrients to the liver for metabolism and processing.

Metabolism: -

Fructose metabolism occurs entirely in the liver. Through a complicated process called fructolysis, fructose undergoes several chemical and structural changes with the help of aldolase B (an enzyme in the liver).

Extra fructose needs to be changed into glycogen by liver & stored in liver, once the storage is full in liver then liver convert it into triglycerides & triglycerides are further converted by liver into very low-density lipoprotein (VLDL) & stored in fat cells & muscles. Excessive fructose is excreted in urine.

Basic clinical pharmacology of fructose: -

Fructose has low glycemic index & results in moderate release of insulin in the blood stream relative to glucose & sucrose; fructose gives the least dental caries among other types of sugars, fructose is more sweeter than other types of sugar; it does not raises blood sugar much as glucose does, it is used as sources of energy in the body, excessive intake of it may cause fatty liver, metabolic disorder, blood pressure, increase lipids, increase in uric acid level, increase in free radicals etc.

- ***Sucrose: -***

Sucrose is common sugar. It is a disaccharide, a molecule composed of two monosaccharides: glucose and fructose. Sucrose is produced naturally in plants, sucrose is digested quickly. A serving of food rich in sucrose can cause a sharp increase in blood sugar that is often followed by a sharp decrease. The sudden rise and fall in blood sugar often affects mood, causing sudden bouts of irritability and fatigue. But vegetables & fruits contain little amount of sucrose.

- ***Maltose: -***

Maltose is also known as maltobiose or malt sugar, it is a disaccharide; maltose is a disaccharide that is made up of two glucose units. It has a slightly sweet taste, but it's most important function is during digestion. Since most carbohydrates are in a form that cannot be absorbed, it is important for these carbohydrates to be broken into smaller pieces.

Absorption & digestion of amino acid.

When we eat high-protein foods, body breaks down protein into amino acids and peptides through digestive enzymes, such as pepsin & pancreas produces trypsin, chymotrypsin and other that aid in protein digestion.

Pepsin is the primary enzyme responsible for digesting protein; it acts on the protein molecules & breaks the bonds – called peptide bonds – that hold the protein molecules together. Next, these smaller chains of amino acids move in the stomach & then in small intestine where they're further broken down by enzymes released by the pancreas. Small intestine contains finger-like extensions called micro-villi. These structures enhance its ability to absorb dietary nutrients. Now the semi digested material pass through brush border and baso-lateral membranes of small intestine & di-tripeptides are absorbed by passive transport (facilitated or simple diffusion) or active transport (Na+ or H+ co-transporters) pathways. Di and tripeptides are more efficiently absorbed than free amino acids which in turns are better absorbed than oligopeptides. They're released into the bloodstream and used for various biochemical reactions.

Each amino acid has a different role in the human body. Upon absorption, some amino acids are incorporated into a new protein. Some fuel your muscles and support tissue repair. Others are used as a source of energy.

Tryptophan and tyrosine, for example, promote brain health. These amino acids support the production of neurotransmitters, leading to increased alertness and optimum nerve responses. Tryptophan also assists with serotonin production, lifting your mood and keeping depression at bay.

Phenylalanine serves as a precursor to melatonin, epinephrine, dopamine and other chemicals that regulate your mood and bodily functions. Methionine helps your body absorb selenium and zinc, two minerals that promote overall health. Some amino acids, such as isoleucine, play a vital role in hemoglobin production and glucose metabolism.

- ***Tryptophan: -***

It is an amino acids (protein) that is useful in bio-synthesis of protein; it is essential in human because body cannot make it); it is a precursor of neuro-transmitter serotonin, melatonin, vitamin B3; it is a sedative also.

Main sources of tryptophan: -

Salmon oil, egg, spinach, milk, seeds, fenugreek seed, soy products, nuts, fish, meat, wheat, banana etc.

Basic pharmacokinetics of tryptophan (based on human intake in natural food products): -

It is absorbed in small intestine & reached the blood circulation, it passes the blood brain barrier & in brain cells it is metabolized into indolamine neuro-transmitter, niacin, a common example of indolamine is serotonin derivative from tryptophan. Tryptophan is converted into serotonin in the brain & body; it is believed that tryptophan supplements should be taken with carbidopa, which blocks the blood brain barrier. (Serotonin (5HTP) 5 hydroxytryptamine, is a monoamine neuro-transmitter. It contributes in feelings of well-being, happiness, reward, learning, memory, many physiological functions).

In the pathway of tryptophan/serotonin, melatonin hormone is produced. Melatonin regulates sleep-wake cycle. It is primarily released by pineal gland in brain. It controls circadian (daily clock) rhythms.

Pineal gland releases it at night more & very little in day light. It improves immune system function.

Natural sources of melatonin are tomato, pomegranate, olive, grapes, broccoli, cucumber, barley, seeds, nuts etc.

Fructose malabsorption causes improper absorption of tryptophan in intestine thus leading to low level of it & may cause depression.

Basic clinical pharmacology of tryptophan: -

It is necessary for normal growth of infants; nitrogen balance in adults, it aids in sleep pattern, mood. It is necessary for melatonin & serotonin formation in body, it enhances mental & emotional well being, manages pain tolerance, weight etc. it also helps in build muscle tissue, essential for vitamin B3 production, relives insomnia, reduces anxiety, depression, migraine, OCD, helps immune system, reduces cardiac spasms, improves sleep patter etc.

- ***Threonine: -***

It is an amino acid used in biosynthesis of proteins; it is an essential amino acid important for tooth enamel, collagen, elastin, nervous system, fats metabolism, it prevents fats buildup in liver, useful in intestinal disorders, anxiety, and depression.

Main sources of threonine: -

Cheese, chicken, fish, meat, lentil, black seed, nuts, soy etc.

Basic clinical pharmacology of threonine: -

It is useful in nervous system disorders, multiple sclerosis, spinal spasticity, makes bones, joints, tendons, ligament stronger, it helps the immune system, promotes heart health.

- ***Isoleucine: -***

It is an amino acid that is used in the biosynthesis of proteins, it is an essential amino acid means the body cannot make it & we depend on food sources, it plays & helps many functions of the body.

Main sources of isoleucine: -

Meat, mutton, fish, cheese, egg, seeds, nuts, soybeans, milk, legumes, fenugreek seed etc.

Basic pharmacokinetics of isoleucine (based on human intake in natural food products): -

It is absorbed in small intestine by sodium-dependant active transport. It is metabolized in liver.

Basic clinical pharmacology of isoleucine: -

It promotes glucose consumption & uptake, it is anti-catabolic, enhances athletic performance & best for pre-workout, it acts on wound healing, detox of nitrogenous waste in the body, stimulates immune system, promotes secretion of many hormones, helps in heamoglobin formation, regulating blood glucose, energy in the body, built muscles, helpful to brain for its function.

- ***Leucine: -***

It is branched chain amino acid (BCAA) it is ketogenic amino acid; it is necessary when we do exercise, it stimulates protein synthesis & assists in muscle building.

Main sources of leucine: -

Cheese, soyabean, meat, nuts, chicken, seeds, fish, seafood, beans.

Basic clinical pharmacology of leucine: -

It helps regulate blood glucose, promotes growth, recovers the muscles & bone tissues, acts on production of growth hormones, repairs the tissues, essential for muscle building, it burns fats, controls obesity, promotes lean muscles growth.

- ***Lysine: -***

It is an essential amino acid, which our body cannot prepare and we need to eat it from food sources. It necessary for many body functions, acts in building blocks of protein (muscles).

Main sources of lysine: -

Red meat, chicken, egg, fish, beans, lentils, wheat germ, nuts, soybeans, spirulina, fenugreek seed, shrimp, pumpkin seed, tuna, cheese, milk etc.

Basic pharmacokinetics of lysine (based on human intake in natural food products): -

It is absorbed from the lumen of the small intestine into the enterocytes by active transport, it undergo first pass metabolism in liver & is metabolized in liver.

Basic clinical pharmacology of lysine: -

It helps the body in tissue growth, repair muscles injury, promote collagen formation, help the body to produce enzymes, antibodies, hormones, supports immune sytem, its deficiency causes fatigue, irritability, nausea, hair loss, anorexia, inhibited growth, anemia, problems with reproductive system, it is very helpful in treating cold sores (herpes), control blood pressure, diabetes, osteoporosis, helps athletes performance, helpful in treating cancers, reduces anxiety, increase absorption of calcium, improves digestion & prevent leaky gut, helpful in pancreatitis.

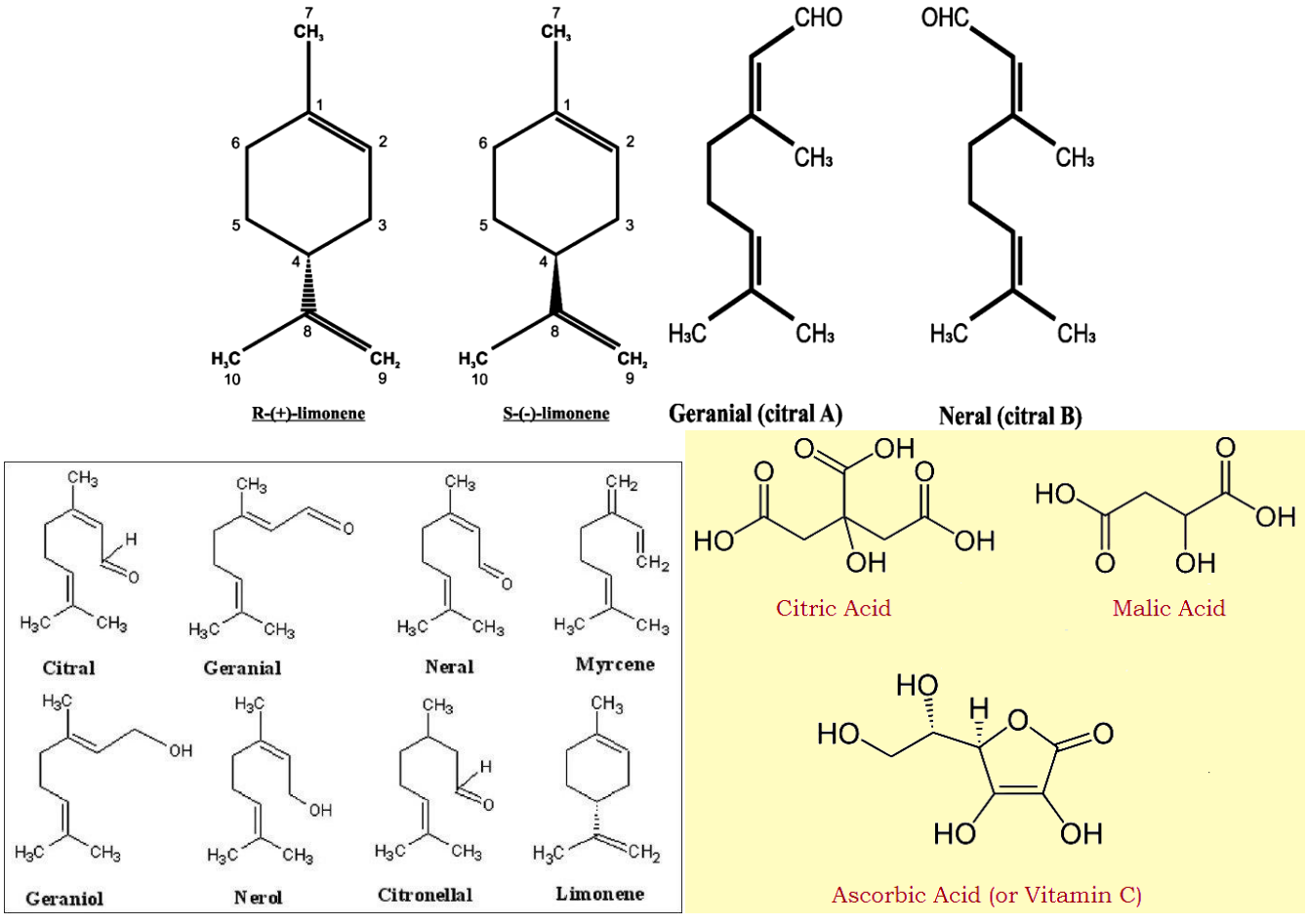
- ***Valine: -***

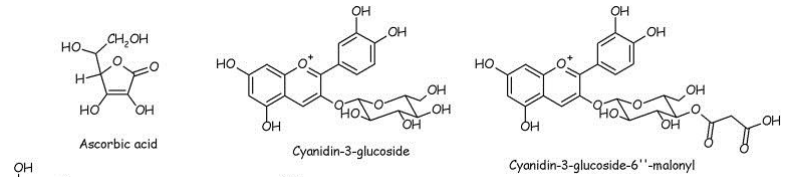
It is an essential nutrient for vertebrates, biosynthesis of protein; it is an aliphatic & extremely hydrophobic essential amino acid; it is branched chain of amino acid (BCAA); it is important for growth, repair, blood glucose regulation, for energy; it stimulates CNS, proper mental function.

Main sources of valine: -

Cheese, soy, beans, nuts, fish, meat, chicken, mushroom, seeds, nuts, whole grains etc.

- ***Main chemical structures of all citrus fruits: -***

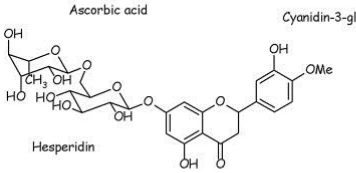




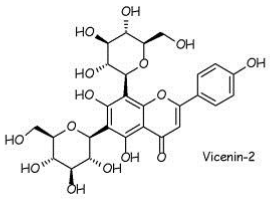
Ascorbic acid

Cyanidin-3-glucoside

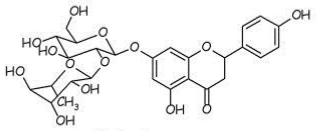
Cyanidin-3-glucoside-6''-malonyl



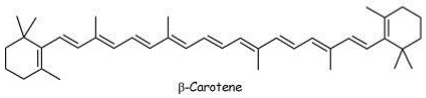
Hesperidin



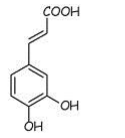
Vicenin-2



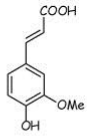
Naringenin



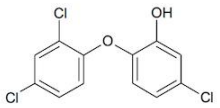
β-Carotene



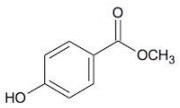
Cinnamic acid



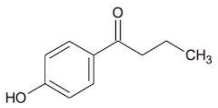
Ferulic acid



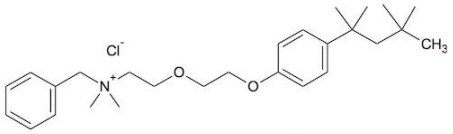
Triclosan (**1**)



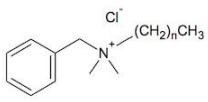
Methyl-*p*-hydroxybenzoate
(methyl paraben, **2**)



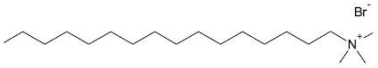
Propyl-*p*-hydroxybenzoate
(propyl paraben, **3**)



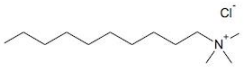
Benzethonium chloride (**4**)



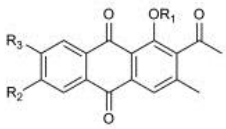
Benzalkonium chloride (**5**)



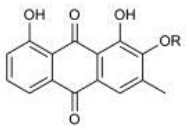
Cetrimonium bromide (**6**)



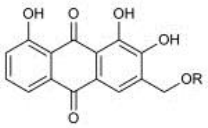
Decyltrimethylammonium chloride
(**7**)



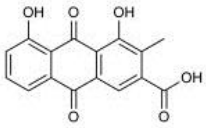
Kwanzoquinone A (R_1 = H, R_2 = CH_3 and R_3 = H) **(43A)**
Kwanzoquinone B (R_1 = H, R_2 = H and R_3 = CH_3) **(43B)**



2-Hydroxychrysophanol (R = H) **(42)**
Kwanzoquinone C (R = β-D-Glucopyranoside) **(43C)**
Kwanzoquinone D (R = Malonyl-(1→6)-β-D-Glucopyranoside) **(43D)**



Kwanzoquinone E (R = H) **(43E)**
Kwanzoquinone F (R = β-D-Glucopyranoside) **(43F)**



Kwanzoquinone G **(43G)**

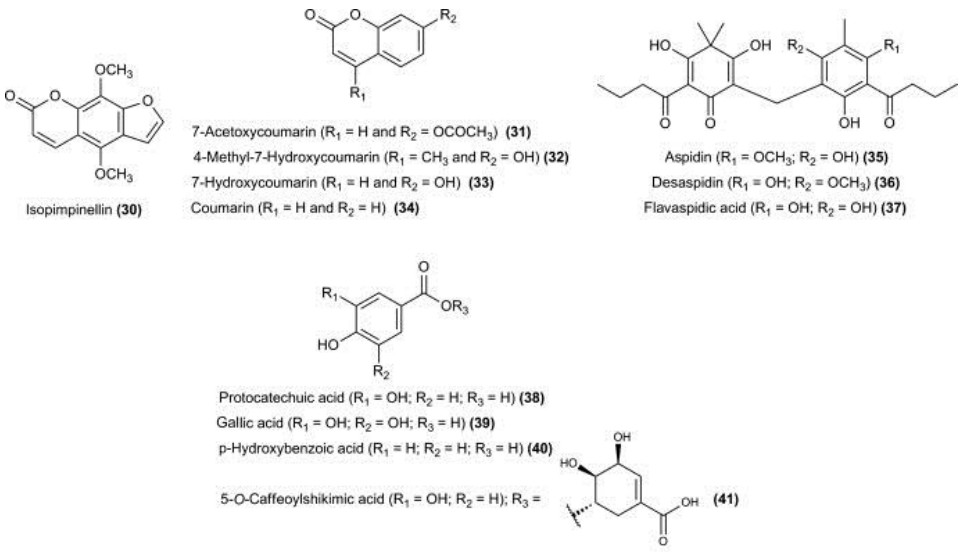
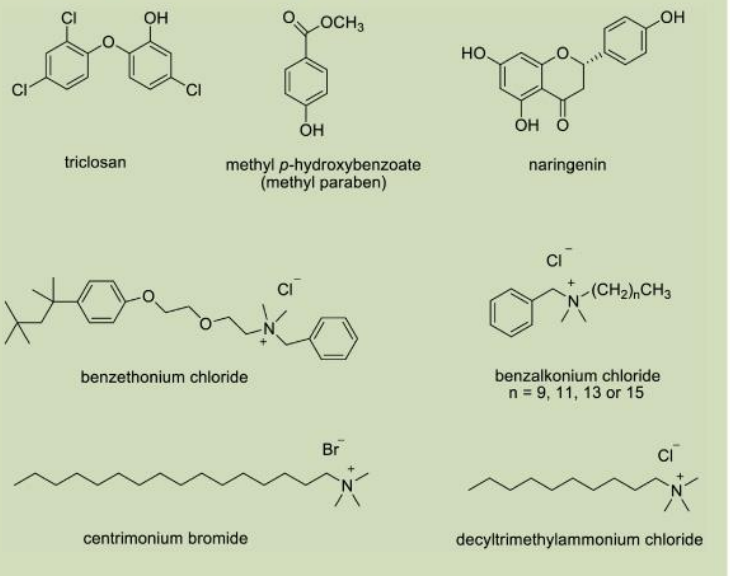


Figure 1. Structures of the Principal Disinfectants/Microbicides Found in Products Labeled "Grapefruit Seed Extract," and the Structure of Naringenin, the Most Abundant Flavonoid in Grapefruit.



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- ***Research on oranges: -***

The antibacterial activity of essential oil, crude extracts and pure compounds of *C. sinensis* has been demonstrated in several studies. Silver nanoparticles synthesized at 25 °C and 60 °C using *C. sinensis* peel aqueous extract, showed diverse zones of inhibition using the agar well-diffusion method against *Escherichia coli* (25 °C 12.5 mm, 60 °C 16.0 mm), *Pseudomonas aeruginosa* (25 °C 11.7 mm, 60 °C 13.4 mm) and *Staphylococcus aureus* (25 °C 7.8 mm, 60 °C 9.2) [41]. Another study showed that silver nanoparticles synthesized by mixing silver nitrate solution with *C. sinesis* juice for 2 h at 37 °C displayed minimum inhibitory concentration (MIC) values of 20 µg/mL for *Bacillus subtilis* and *Shigella* and 30 µg/mL for *S. aureus* and *E. coli*. Antibiofilm activity of 80% to 90% was observed at 25 µg/mL.

Antifungal activity of plant crude extracts, oils and secondary metabolites of *C. sinensis* has been reported. The compound 3-[4-hydroxy,3-(3-methyl-2-butenyl)-phenyl]-2-(*E*)-propenal isolated from hexane extract of injured peel of *C. sinensis* L. Osbeck cv. Valencia or *C. paradisa* MacFaden cv. Marsh showed activity against *Penicillium digitatum* and against *Cladosporium cucumerinum* on Si gel tlc plates using 7 µg of compound.

Parasitic diseases, are serious worldwide public health problems, and *C. sinensis* is an alternative in the treatment and control of these diseases. The hexane (IC_{50} 42.13 µg/mL), chloroform (IC_{50} 88.03 µg/mL), ethyl acetate (IC_{50} 26.67 µg/mL), acetone (IC_{50} > 100 µg/mL), and methanol (IC_{50} > 100 µg/mL) extracts of *C. sinensis* peel, displayed moderate antimalarial activity against chloroquine (CQ)-sensitive (3D7) strain of *Plasmodium falciparum.*

- ***Research on lemon: -***

C. limon nanovesicles have been isolated from the fruit juice using the ultracentrifugation method and purification on a 30% sucrose gradient, using an in vitro approach. The study showed that isolated nanovesicles (20 µg/mL) inhibited cancer cell proliferation in different tumour cell lines, by activating a TRAIL-mediated apoptotic cell death. Furthermore, *C. limon* nanovesicles suppress chronic myeloid leukemia (CML) tumour growth in vivo by specifically reaching the tumour site and by activating TRAIL-mediated apoptotic cell processes.

Another study has shown that an 80:20 methanol:water extract from lemon seeds induces apoptosis in human breast adenocarcinoma (MCF-7) cells, leading to the inhibition of proliferation. This extract showed the highest (29.1%) inhibition of MCF-7 cells in an MTT assay (Cell Proliferation Kit), compared to ethyl acetate, acetone and methanol extracts. The results suggest that aglycones and glycosides of the limonoids and flavonoids present in the 80:20 methanol:water extract may potentially serve as a chemopreventive agent for breast cancer .

It has been shown that the antioxidant activity of the flavonoids from *C. limon*—hesperidin and hesperetin—was not only limited to their radical scavenging activity but also augmented the antioxidant cellular defences via the ERK/Nrf2 signalling pathway.

Various in vitro and in vivo studies have been conducted to evaluate hesperidin metabolites, or their synthetic derivatives, at their effectiveness in reducing inflammatory targets including NF-κB, iNOS, and COX-2, and the markers of chronic inflammation.

- ***Research on grapefruit: -***

The HMG-CoA reductase inhibitor, lovastatin, has been reported to produce a serious adverse skeletal muscle effect, rhabdomyolysis, when administered with drugs that inhibit CYP3A4 including itraconazole, erythromycin and cyclosporin. Lovastatin is a prodrug which normally undergoes extensive presystemic elimination. Less than 5% of lovastatin is hydrolyzed to the pharmacologically active metabolite, lovastatin acid, with the majority biotransformed by other primary routes mediated by CYP3A4 . Lovastatin and active metabolite AUCs were increased more than twenty-fold when administered with itraconazole suggesting the adverse effect has a pharmacokinetic basis. Rhabdomyolysis has also been reported with simvastatin [88, 89] and pravastatin. Thus, a clinically important interaction may occur between grapefruit juice and lovastatin and possibly other HMG-CoA reductase inhibitors.

Identification of the active ingredient(s) in grapefruit juice would permit evaluation of this type of interaction with other foods. The apparently non-toxic active ingredient(s) in grapefruit juice might be also used commercially to dose orally drugs that are currently active only by the intravenous route because of complete presystemic metabolism involving CYP3A4 or to produce higher and more dependable drug bioavailability and clinical response among or within individuals. In addition, because hepatic CYP3A4 activity does not appear to be altered by grapefruit juice, a major mechanism for systemic drug inactivation is not jeopardized. However, the persistence of hepatic CYP3A4 activity means that it would not likely be possible to produce complete oral drug bioavailability. Recently a study was reported that tested the hypothesis that naringin and/or 6′,7′-dihydroxybergamottin in grapefruit juice are primarily responsible for the interaction with felodipine in humans. The approach was to separate grapefruit juice by centrifugation and ultrafiltration into supernatant and particulate fractions. Then, the effects on oral felodipine pharmacokinetics of these fractions, of grapefruit juice containing a comparable amount of both fractions and of water were compared in healthy male volunteers. Because the amounts of naringin and 6′,7′-dihydroxybergamottin were found to be greater in the supernatant fraction (148 mg and 1.85 mg, respectively) than the particulate fraction (7 mg and 0.60 mg, respectively), it was postulated that the activity of the supernatant fraction would range from being greater than the particulate fraction to equivalent to the grapefruit juice. Felodipine AUC were higher with supernatant fraction and particulate fraction compared to water demonstrating that both fractions contained the active substance(s). However, the supernatant fraction had lower felodipine AUC than the particulate fraction. It was concluded that naringin and 6′,7′-dihydroxybergamottin are not the major active ingredients although they may contribute to the interaction. Recently, other furanocoumarins isolated from grapefruit juice were reported to inhibit *in vitro* human CYP3A. However, a final decision on their importance to the interaction must await results from *in vivo* testing in humans.

- ***Research on pomelo: -***

Leaves of Pomelo or Citrus maxima were studied for hepato-toxicity in rats against paracetamol induced hepato-toxicity. Successive extraction was done and methanolic extract was evaporated to get crude extract. Paracetamol were used for liver damage in rats. Standard drug silymarin were compared with the methanolic extract of Citrus maxima leaves. The effect of the methanolic extract of Citrus maxima had significant effect on thiobarbituric acid reactive substances. Reduced levels of the glutathione and catalase activity were restored to normal levels using methanolic extract of Citrus maxima leaves. The histopathological studies have also shown that the hepatocellular vacuolization and focal hepatic necrosis in paracetomol control animals is significantly reduced in the MECM 400 mg/kg treated animals and silymarin treated animals. CCl4 induced hepatotoxicity model were used and Citrus maxima peels were found to posses the protective action against hepatic damage induced by CCl4. Anti oxidant compound like caffeic acid and epicatechin are found to be responsible for the effectiveness of Citrus maxima peel powder against liver disorder.

Anti bacterial activity of Pummelo against Escherichia coli and Salmonella typhimurium were tested. Ethanolic extract of the Pericarp, Mesocarp, Segment membrane were prepared and zone of inhibition of the various extracts using cup cylinder method were tested in the culture of E.coli and S.typhimurium. The pericarp, mesocarp and segment membrane extracts generated zone of inhibitions measuring 17.10, 18.00 and 17.03 mm for S. typhimurium, respectively at 100% concentration. E. coli was noted to be inactive in all three sample extracts at 100% concentration.

Citrus maxima and citrus paradisii juices were studied for inhibition of the Angiotensin converting enzyme and hypocholesterolemic activity. The interaction of the citrus fruit juices with ACE revealed that the juices inhibited ACE activity in a dose-dependent manner.

- ***Research on citron: -***

A bibliographic research was carried out independently by two researchers (blinded to the authors and initially on results) in the major scientific databases and search engines of peer-reviewed literature from 2000 to July 2018, on life sciences and biomedical topics (PubMed, Scopus, Embase, Web of Science, and Google Scholar). The following keywords or combination of keywords "Citrus anxiety", "*Citrus aurantium* axiety", "*Citrus sinensis anxiety"*, and "clinical trials" were used. Analysis included only articles written in English and published on peer-reviewed scientific journals describing clinical trials and applications of *Citrus aurantium* or *Citrus sinensis* EOs. Articles describing the effects of products containing *Citrus aurantium* or *Citrus sinensis* EOs in combination with other active substances including medicinal plants derivatives were also excluded. The selection and the review of clinical studies written in English regarding *Citrus aurantium* or *Citrus sinensis* EOs were performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Methodological quality was assessed using validated tools such as the Consort Statement in Reporting Clinical Trials with Herbal Medicine Intervention (Section 4) and the Jadad Scale. From the eligible articles, two investigators independently extracted data by using a standard data extraction form. Data were considered for therapeutic indication, design of the study, number, sex, and age of subjects, endpoints, adverse effects, and outcome. In all the studies, reporting of adverse reactions was monitored. The absence of adverse reactions was defined as "not reported." All the authors reviewed all the eligible articles and resolved by discussion any uncertainty regarding the statistical method used to handle the missing data.

To summarizes for each preclinical study the authors, the route of administration, animal species, experimental model to study anxiety, dose, and observed effects of *Citrus aurantium* or *Citrus sinensis* administration; summarize authorship of the paper, therapeutic indication, study design, subjects involved, endpoints, adverse effects, and outcome of all the clinical trials regarding use of *Citrus aurantium* or *Citrus sinensis*, respectively. CONSORT items for trials with herbal medicine interventions applied to clinical studies, for *Citrus aurantium* and *Citrus sinensis*, respectively. Table 6 reports quality assessment of randomized controlled trials by the Jadad scoring system.

In other research: antianxiety effects of *Citrus aurantium* were demonstrated through behavioral experiments carried out with laboratory animals. *C. aurantium* EO oral administration in mice increased exploration of the open arms (time spent) in the elevated plus-maze at a dose that did not impair motor activity observed with open-field and rotarod test, which is indicative of anxiolytic-like effect in male mice.

- ***Research on lime: -***

The traditional uses or phytochemical properties of *C. aurantifolia* from several literature reviews are described as antibacterial, antidiabetic, antifungal, antihypertensive, anti-inflammation, anti-lipidemia, antioxidant, anti-parasitic, and antiplatelet activities. It is used for the treatment of cardiovascular, hepatic, osteoporosis, and urolithiasis diseases and acts as a fertility promoter. Moreover, it can be used for insecticide activity.

Cancer Incidence

Cancer is a serious public health problem worldwide that is the second leading cause of death, exceeding only by heart disease. A total of 1.6 million new cancer cases and more than five hundred thousand cancer deaths are recorded in the United States in 2015. The natural products were studied, and it was tried to develop a novel anti-cancer therapy for several years. The anticancer property of *Citrus aurantifolia* was reviewed in this article for update.

Colon Cancer

Patil *et al*. reported that *C. aurantifolia* fruit from Texas, USA, consists of at least 22 volatile compounds, and its major compounds were limonene (30%) and dihydrocarvone (31%). About 100 µg/ml of *C. aurantifolia* extract can inhibit the growth of colon SW-480 cancer cell in 78% after 48 h of exposure. It showed the fragment of DNA and increased level of caspase-3. After a few years, Patil *et al*. found the new three coumarins from *C. aurantifolia* peel from Texas that were 5-geranyloxy-7-methoxycoumarin, limettin, and isopimpinellin. About 25 µM of *C. aurantifolia* extract can inhibit the growth of colon SW-480 cancer cell in 67% after 72 h of exposure. The result of apoptosis was confirmed by the expression of tumor suppressor gene casapase-8/3, p53, and Bcl-2, and inhibition of p38 mitogen-activated protein kinases phosphorylation.

Pancreatic Cancer

Patil *et al*. reported that the active components of *C. aurantifolia* juice contain rutin, neohesperidin, hesperidin, and hesperetin. They also found limonoid substances such as limonexic acid, isolimonexic acid, and limonin. Moreover, 100 µg/ml of *C. aurantifolia* juice extract can stop 73–89% of pancreatic Panc-28 cancer cells growth after 96 h of exposure. The result of apoptosis was confirmed by the expression of Bax, Bcl-2, casapase-3, and

p53. In the next year, Patil *et al*. reported the five active components of *C. aurantifolia* seeds such as limonin, limonexic acid, isolimonexic acid, β-sitosterol glucoside, and limonin glucoside. They also reported that *C. aurantifolia* extract can stop the growth of pancreatic Panc-28 cancer cells with inhibitory concentration 50% (IC50) of 18–42 μM after 72 h of exposure. Moreover, the order of the induction of apoptosis was isolimonexic acid > limonexic acid > sitosterol glucoside > limonin > limonin glucoside, based on the expression ratio of Bax/Bcl-2.

Breast Cancer

Gharagozloo *et al*. reported that the 125–500 μg/ml of *C. aurantifolia* fruit juice extract from Iran inhibits the growth of breast MDA-MB-453 cancer cell after 24 h of exposure. Adina *et al* reported that the 6 and 15 μg/ml of *C. aurantifolia* peel extract from Indonesia inhibits the growth of breast MCF-7 cancer cell at G1 and G2/M phase, respectively, after 48 h of exposure. The expression of p53 and Bcl-2 was also observed, which indicated the apoptosis.

Lymphoma

Castillo-Herrera *et al*. reported that the limonin extract from *C. aurantifolia* seed from Mexico inhibits the growth of L5178Y lymphoma cells with IC50 of 8.5–9.0 μg/ml.

- ***Conclusion for oranges: -***

Natural products have been and will be important sources of new pharmaceutical compounds. Recently, there has been a renewed interest in natural product research due to the failure of alternative drug discovery methods to deliver many lead compounds in key therapeutic areas. In this sense, considering the health benefits of *C. sinensis* it presents excellent options for treating or helping in a disease due to its bioactive compounds (drug candidates) that show important activities or for developing new products, there is the need for public enlightenment on the importance of *C. sinensis* and finding and discovering new and effective drug compounds, so this review represents an excellent source of information about this natural product.

- ***Conclusion for lemons: -***

The presented review proves that *C. limon* is a very attractive object of different scientific studies. The *C. limon* fruit is a raw material that can be used in different forms, e.g., extracts, juice and essential oil. The rich chemical composition of this species determines a wide range of its biological activity and its being recommended for use in phytopharmacology. The studies have focused on the essential oil and its main active compound—D-limonene. Extracts from *C. limon* fruits are rich in flavonoids such as naringenin and hesperetin.

Current pharmacological studies have confirmed the health-promoting activities of *C. limon*, especially its anti-cancer and antioxidant properties. *C. limon* also finds increasing application in cosmetology and food production.

There has been some biotechnological research aimed at developing effective in vitro micropropagation protocols for *C. limon*.

- ***Conclusion for grapefruit: -***

A single glass of grapefruit juice has the potential to augment the oral bioavailability and to enhance the beneficial or adverse effects of a broad range of medications, even by juice consumed hours beforehand. Grapefruit juice acts by inhibiting presystemic drug metabolism mediated by CYP3A isoforms in the small bowel. The interaction appears particularly relevant for medications with at least a doubling of plasma drug concentration or with a steep concentration-response relationship or a narrow therapeutic index. Patients that appear particularly susceptible have high small bowel CYP3A4 content, hepatic insufficiency or a pre-existing medical condition which predisposes to enhanced, excessive or abnormal drug effects. Since grocers do not take a drug history, physicians, pharmacists and other health professionals should educate patients about consumption of grapefruit juice with medications.

Isolation of the active ingredient(s) may lead to identification of other foods producing this interaction or to its incorporation into pharmaceutical formulations. Further research is required to understand the interaction better during routine grapefruit juice consumption, at amounts considered safe for administration with drugs and with different patient populations. Nevertheless, the serendipitous observation of increased plasma felodipine concentrations by grapefruit juice has provided fundamental new knowledge to improve pharmacotherapy and to stimulate research.

- ***Conclusion for pomelo: -***

Citrus maxima depicted the fact that it is used as a cure for variety of ailments. Following the traditional and folk claims, very little efforts have been made by the researchers to explore the therapeutic potential of this plant. It is interesting to note that pure compounds and crude organic extracts of leaves of Citrus maxima have been screened for some pharmacological activities and found to possess analgesic, anti inflammatory, anti tumor, hepato-protective activity and CNS activity Stem bark of the plant possess anti diabetic activity, and Juices are screened for hypo-cholesterolemic and anti oxidant activity. Peel was scientifically proved for hepato-protective, anti bacterial, analgesic and anti inflammatory activity. Citrus maxima are a high value medicinal plant. In future

study, the isolated principles from Citrus maxima needs to be evaluated in scientific manner using scientific experimental animal models and clinical trials to understand exact molecular mechanism of action, in search of lead molecule from natural resources.

- ***Conclusion for citron: -***

Results from various studies indicates that Citrus medica leaves possesses anti-helmintic and estrogenic activities; fruit has analgesic, anticancer, insulin secretagogue & antiulcer activities; peel possesses many qualities including hypoglycaemic, hypocholesterolemic, hypolipidemic, antimicrobial and anti-helmintic properties; seed has antidiabetic, hypocholesterolemic, hypolipidemic and estrogenic activities. Further clinical studies should be conducted, as well as studies in multiple animal-based models using a variety of suitable biochemical markers to understand its mechanism of action. As for its use in fighting cancer, confirmatory studies in several other animal tumor systems must be conducted for more definitive findings. So far the activities attributed to various parts of it are analgesic, anti-helmintic, antiulcer mentioned in claims have been proved through research, but other activities like sedative, antipyretic, antitussive, bronchodilator, stomachic, laxative and cardio-tonic require further scientific validation. It is also important to recognize that Citrus medica may be effective not only in isolation, but may actually have a potentiating effect when given in combination with other herbs or drugs.

- ***Conclusion of lime: -***

Even though citrus is a common fruit and easy to use in daily consumption, it contains many beneficial substances for human health. It may be a miracle fruit. The phytochemical substances such as alkaloids, carotenoids, coumarins, essential oils, flavonoids, phenolic acids, and triterpenoids exist in citrus abundantly. All of these substances have their board range of pharmacological properties, especially anticancer property. *C. aurantifolia* was studied for its effect against carcinogenesis by mechanisms such as stopping cancer cell mobility in circulatory system; so, inhibiting the metastasis, blocking the angiogenesis, and inducing tumor suppressor gene and apoptosis. The present review suggests that *C. aurantifolia* consumption may have a change to use for cancer therapy.