Lesson no. 35 Miswaak (tooth twig).

The miswak is also called as miswaak, siwak, sewak, Arabic: (سواك or مسواك) In Malaysia, miswak is known as Kayu-Sugi (Malay for 'chewing stick'). It is teeth cleaning twig made from the Salvadora persica tree (known as arāk, أراك, in Arabic). It is reputed to have been used over 7000 years ago.
The miswak's properties have been described thus: "Apart from their antibacterial activity which may help control the formation and activity of dental plaque, they can be used effectively as a natural toothbrush for teeth cleaning. Such sticks are effective, inexpensive, common, available, and contain many medical properties". It also features prominently in Islamic hygienical jurisprudence.
The miswak is predominant in Muslim-inhabited areas. It is commonly used in the Arabian peninsula, the Horn of Africa, North Africa, parts of the Sahel, the Indian subcontinent, Central Asia and Southeast Asia.
The World Health Organization (WHO) recommended the use of the *miswak* in 1986, but in 2000 an international consensus report on oral hygiene concluded that further research was needed to document the effect of the miswak. Some of this further research has been done on a population of 203, and concluded, in turn, "that the periodontal status of miswak users in this Sudanese population is better than that of toothbrush users". Yet another comparative study conducted on a sampling of 480 Saudi Arabian adults found that "the level of need for periodontal care in the sample chosen is low when compared with the findings of similar studies undertaken in other countries. The frequent use of the 'Miswak' was associated with a lower need for treatment".
A 2016 paper has been published comparing human DNA left on used miswak and toothbrushes, including the effect of time, to determine whether miswak is a reasonable source of DNA when found at crime scenes. The conclusion was that miswak contains a high enough quantity of DNA, and retained good DNA profiling; and when compared to toothbrushes, miswak is a reasonable source of DNA for forensic profiling. In addition, time of storage up to 4 months had no or little effects on results.
Studies indicate that Salvadora persica extract exhibits low antimicrobial activity compared to other oral disinfectants and anti-plaque agents like triclosan and chlorhexidine gluconate.
Mouth rinses containing chlorhexidine was with maximum antibacterial activity, while cetylpyridinium chloride mouth rinses were with moderate and miswak extract was with low antibacterial activity.
However, the benefits of triclosan were discounted by the United States Food and Drug Administration in 2016 and its safety is uncertain as a hygiene product ingredient. Chlorhexidine gluconate was also linked to serious allergic reactions, albeit rarely.
It is mentioned in Hadith that miswaak was used by Prophet Muhammad (s.a.w) very regularly & advised to use it & also mentioned benefits of it; for more Islamic detail on miswaak read my book Tibb e Nabawi part 2 lesson no. 57 page 177 onwards or visit my website www.tib-e-nabi-for-you.com or direct link to lesson Miswaak http://www.tib-e-nabi-for-you.com/miswaak.html
It is mentioned in many books of Hadith like: -
Bukhari; An-Nasai; Abu Dawud; Ibn Majah; Tirmizi ; Kanzul-ummal; Mojam Ausaf; Al Bahurur-Raiq; Shami : volume 1 page 85; Musnad Ahmed : 26340; Kashtul Khifa : 1399.

- ***Basic encyclopedia of miswaak: -***

For tooth twig following shrubs or trees can be used Olive, Neem (*Azadirachta indica*), orange (*Citrus sinensis*), lime (*Citrus aurantifolia*), Salvadora persica etc; but Salvadora persica is best to be used as miswaak (tooth twig). We will learn salvadora persica.

- ***Names of salvadora persica: -***

1. Quranic name of Miswaak is KHAMT.
2. Hadees name of Miswaak is SIWAK. (السواك)
3. Arabic name of Miswaak is ARAK, KHARDAL & SIWAK.
4. Hindi & Urdu name of Miswaak is PEELU, ARAK.
5. English name of Miswaak is MUSTARD.
6. Latin name of Miswaak is Salvadora persica Linn
7. It belongs to Salvadoracea family.
8. In other languages it is called as: locally called as kharijal; BENG—Jhal; Mah—Khakhin Kickni, Miraj, Pelu, Pilva; GUJ—Kharijal, Piludi; TEL—Ghunia, Varagogu; TAM—Kalawa, kakkol, vivay; KAN—Goni-mara; and ORIYA—Kotungo, pilu.

- ***Salvadora persica tree: -***


It is widely distributed in the arid regions of India and often on saline soils. It is an upright evergreen small tree or shrub, seldom more than 1 ft in diameter reaching a maximum height of 3 m. The fresh leaves are eaten as salad and are used in traditional medicine for cough, asthma, scurvy, rheumatism, piles, and other diseases. The use of miswak is a pre-Islamic custom used by ancient Arabs to get their teeth white and shiny. The beneficial effects of miswak in respect of oral hygiene and dental health are partially due to its mechanical action and partially due to pharmacologic action. Salvadora persica is a large, well-branched evergreen shrub or small tree having soft whitish yellow wood. S. persica prefers sandy soils and areas with high groundwater. Drought-tolerant, deep irrigation in summer will serve to improve the shrub's appearance. With its high salinity tolerance, it has great potential for reclaiming saline soils. Grown in plantations or hedges, S. persica coppices well and is excellent as a shelterbelt, windbreak and in sand dune reclamation. It is prone to some pests and diseases, e.g. Cistanche tubulosa, a root parasite, and also defoliating insects. S. persica is an excellent desert shrub, requiring no maintenance.

- ***Bark: -***


Bark of old stems is rugose, branches are numerous, drooping, glabrous, terete, finely striate, shining, and almost white. Stem bark is used as an ascarifuge and also in gastric troubles.

- ***Leaves: -***



Leaves are somewhat fleshy, glaucous, 3.8–6.3 by 2–3.2 cm in size, elliptic lanceolate or ovate, obtuse, and often mucronate at the apex, the base is usually acute, less commonly rounded, main nerves are in 5–6

pairs, and the petioles 1.3–2.2 cm long and glabrous. The leaves are eaten as a vegetable in the eastern tropical Africa and are used in the preparation of a sauce, and tender shoots and leaves are eaten as salad. Leaves are bitter in taste, corrective, deobstruent, astringent to the bowels, tonic to the liver, diuretic, analgesic, anthelmintic, useful in ozoena and other nose troubles, piles, scabies, leukoderma, lessening inflammation, and strengthening the teeth. Leaves are pungent and are considered in Punjab as an antidote to poison of all sorts and in south of Bombay as an external application in rheumatism. The juice of the leaves is also used in scurvy. The elliptic to almost circular, rather fleshy leaves have a high salt content and are light to dark green. Leaves make good fodder for livestock, since they have high water content and are rich in minerals.

- ***Flower: -***

The flowers are greenish yellow in color, in axillary and terminal compound lax panicles 5–12.5 cm long, numerous in the upper axils, pedicels 1.5–3 mm long, bracts beneath the pedicels, ovate and very caducous. Calyx is 1.25 mm long, glabrous, cleft half-way down, lobes rounded. Corolla is very thin, 3 mm long, deeply cleft, persistent, lobes are 2.5 mm long, oblong, obtuse, and much reflexed. Stamens are shorter than corolla, but exserted, owing to the corolla lobes being reflexed. Drupe is 3 mm in diameter, globose, smooth and becomes red when ripe. The small, greenish to yellowish flowers, borne in loose, slender-branched panicles are up to 10 cm long.

- ***Fruits: -***

Fruits are sweet and edible. A fermented drink is reported to be made from the fruits. Fruits possess deobstruent, carminative, diuretic, lithontriptic, and stomachic properties and are used in biliousness and rheumatism. In Sind, it is believed that fruits have a good effect on snake bite. The edible, spherical, fleshy fruit is 5–10 mm in diameter, bright red when ripe and has a sweet, aromatic taste.

- ***Root bark: -***

Root bark is used as a vesicant and is employed as an ingredient of snuff. A paste of the roots is applied as a substitute for mustard plaster and their decoction is used against gonorrhea and vesical catarrh. A decoction of the bark is used as a tonic in amenorrhea and the dose of the decoction is half a teacupful twice daily and as a stimulant in low fevers and as an emmenagogue. It has a wide crown of green, crooked branches, and the twigs have a pleasant fragrance.

- ***Seeds: -***

Seeds have bitter and sharp taste. They are used as purgative, diuretic and tonic seed oil is applied on the skin in rheumatism.

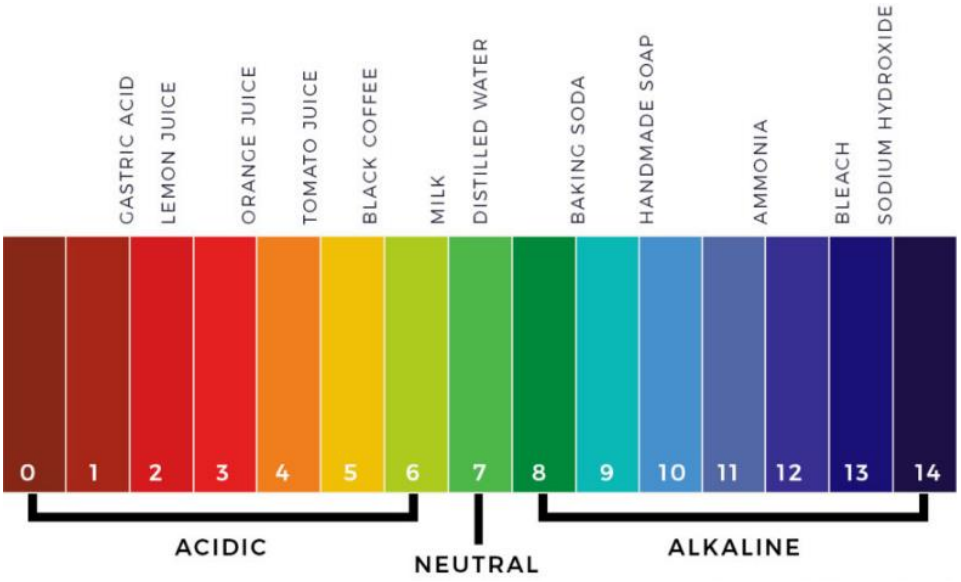
- ***pH of different twig: -***

pH of aqueous extract of chewing sticks of Azadirecta indica (Neem) is 7.0; Olea europaea (Zaitoon) is 6.8; Acacia arabica (Kikar) is 6.1; Salvadora persica (Peelu) is 5.1 to 5.7; Gycosmic pentaphylla (Ban) is 7.2; Capparis aphylla (Khirar) is 5.8 to 6.6

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 it:*** calories of it is not known

- ***Glycemic index & Glycemic load of it: -*** Not known.
- ***Gross health benefits of it: -***

It is good for all teeth & throat

Problems & disease, prevent teeth & oral cavity from diseases, makes gum strong, reduce phlegm, bleeding from gums, prevent & heals gingivitis, mouth ulcers; it prevents mouth & throat cancers, improves digestion, inhibits mouth bacterias, fungus, virus etc, keeps the mouth clean & hygiene, prevents bad odour, prevents sinus, tonsillitis, pharyngitis, laryngitis, prevent lungs diseases, increases taste, salivation etc.

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

Leaves are eaten as a vegetable in eastern tropical Africa and are used in the preparation of a sauce, and tender shoots and leaves are eaten as salad. Fruits are sweet and edible. A fermented drink is reported to be made from the leaves.

Fresh root bark is used as a vesicant and is employed as an ingredient of snuff. A paste of roots is applied as a substitute of mustard plaster and its decoction is used against gonorrhea and vesical catarrh. The extract of root is said to relieve the pain due to spleen troubles. A decoction of bark is used as a tonic and stimulant in low fevers and as an emmenagogue. Stem bark is used as an ascarifuge and for gastric troubles.

Leaves are bitter and possess antiscorbutic, corrective, deobstruent, liver tonic, diuretic, analgesic, anthelmintic, and astringent properties and used in piles, scabies, leucoderma, strengthen the teeth, ozoena, and other nose troubles. A decoction of leaves is used in asthma and cough, and a poultice made out of them is applied to painful piles and tumors. Leaves are also used as an external application in rheumatism. Dried leaves in small doses are given with copious amount of water for the treatment of flatulent dyspepsia.

Fruits possess lithontriptic, carminative, diuretic, aphrodisiac, alexiteric, appetizer, and stomachic properties and are used in biliousness, and rheumatism.

Seeds have a bitter, sharp taste. They are considered as purgative, diuretic, and liver tonic.Seeds oil is applied on the skin in rheumatism.

- ***Pharmacologic activities: -***

Hypolipidemic activity: -

The stems of Salvadora persica are widely used as tooth cleaning sticks in Arabic countries and decoctions show hypocholesterolemic properties. The effects of prolonged administration of a lyophilized stem decoction of Salvadora persica were evaluated in diet induced rat hypercholesterolemic. The preparation was administered for 15 and 30 days and cholesterol, HDL, LDL, and triglycerides plasma levels were assayed. The results showed that the Salvadora persica decoction significantly lowered cholesterol and LDL plasma levels in the rats, proving to be more active at 30 days of treatment. The systemic administration of Triton resulted in a rise in plasma cholesterol and triglyceride levels. The results showed that Salvadora persica decoction was inactive at 18 h after treatment, whereas at 27 h it was able to reduce cholesterol and LDL plasma levels; in all the experiments HDL and triglycerides were unchanged.

Antiulcer activity: -

Salvadora persica possessed significant protective action against ethanol and stress-induced ulcers. This study was designed to confirm the antiulcer activity of Salvadora persica decoction using optical microscopy. The elements of gastric mucosa tended to be reestablished normally in tested rats.

Anticonvulsant activity: -

The effect of Salvadora persica as an anticonvulsant was identified by using stem extracts. The stem extracts show the potentiation of sodium pentobarbital activity and on generalized tonic-clonic seizure produced by pentylentertazol (PTZ) on the rat is reported. The extracts of salvadora persica extend sleeping-time and decreased induction-time induced by sodium pentobarbital; in addition it showed protection against PTZ-induced convulsion by increasing the latency period and diminishing the death rate.

Antifertility activity: -

Miswak extract did not have much effect on female mouse fertility, although it caused a significant decrease in the relative weights of the ovary and an increase in the uterine weights. Exposure of male mice

to miswak resulted in a 72% reduction in pregnancies in untreated females impregnated by test males. The relative weights of the testes and preputial glands were significantly increased and that of the seminal vesicles was significantly decreased in test males. The results indicate that miswak has adverse effects on male and female reproduction systems and fertility.

Antibacterial activity: -

Salvadora persica contain substances that possess plaque inhibiting and antibacterial properties against several types of cariogenic bacteria, which are frequently found in the oral cavity. The growth and acid production of these bacteria is thus inhibited. A comparison of alcohol and aqueous extract of miswak was also made. It was found that alcoholic extract is more effective than aqueous extract for antibacterial activity. In another study, miswak pieces were standardized by size and weight and tested against Streptococcus mutans, Lactobacillus acidophilus, Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, and Haemophilus influenzae. Results found that the strong antibacterial effects against all bacteria tested is due to the presence of a volatile active antibacterial compounds.

The effects of the extracts of Salvadora persica and derum were examined on the proliferation of Balb/C 3T3 of fibroblast and viability of carcinogenic bacteria. For this, aqueous extracts of miswak and derum were prepared and their effects investigated on the growth of Balb/C 3T3 mouse fibroblast by measuring the mitochondrial dehydrogenase activity. Also the effect on the viability of various cariogenic bacteria was also determined. From the obtained results, it is concluded that miswak and derum have adverse effects on the growth of cariogenic microorganisms, with derum as more active than miswak; they show cell proliferation by 156% and 255%, respectively.

Antimycotic activity: -

Aqueous extracts of miswak could be used to reduce the growth of Candida albicans. Such inhibition lasts for up to 36 h at concentrations of 15% and above.

Release of calcium and chloride into saliva: -

Gazi et al. investigated the immediate and medium-term effect of miswak on the composition of mixed saliva. They reported that miswak produced significant increases in calcium (22-fold) and chloride (6-fold), and significant decreases in phosphate and pH, saturation of saliva with calcium inhibits demineralization and promotes demineralization of tooth enamel, whereas high concentration of chloride inhibits calculus formation.

Analgesic effect: -

Mansour et al. studied the analgesic effect of miswak decoction when injected into mice. They found that miswak was more effective against thermal stimuli than against chemical stimuli and also acts as an analgesic.

Cytotoxicity: -

Mohammad et al. investigated the cytotoxic potential of Salvadora persica on gingival and other periodontal structures, using the agar overlay method. Results showed no cytotoxic effect by a freshly cut and freshly used miswak. However, the same plant used after 24 h does contain harmful components. Based on these findings they recommend cutting the used portion of the miswak after it has been used for one day and preparing a fresh part. The cytotoxicity in this study became evident only after 24 h because the agar overlay method depends on the diffusion of the medicament to the agar material.

Tooth paste: -

Some of the known commercial toothpastes produced from Salvadora persica plant are as follows: Sarkan toothpaste (UK), Quali-miswak toothpaste (Switzerland), Epident toothpaste (Egypt), Siwak-F toothpaste (Indonesia), Fluroswak miswak (Pakistan), Dentacare Miswak plus (Saudi Arabia).

Mouthwashes: -

Miswak can be used as mouthwash as it reduces plaque. But no such preparation presently exists in the market.

Endodontic irrigation solution: -

Although the antimicrobial activity of miswak has been reported, its toxicity must be considered. In addition, no report has been yet made on the utilization of the extract as an irrigant solution in endodontic practice. Samh et al. evaluated, in vitro, the effect of different concentrations of miswak extract on L929

cell line in tissue culture and compared the results with sodium hypochlorite (NaOCl). They found a concentration-dependent morphologic change of L929 cell line when exposed to miswak extract and NaOCl. They suspect recovery of the cells after a 4-h exposure period to different miswak extract concentrations.

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

A miswak should be one hand span in length when selected. If it becomes dry, it should be soaked in any water or rose water to soften the end bristles. The end should be cut afresh to ensure hygiene and should never be stored near a toilet or sink. The brush may be created by cutting Salvadora persica's branches instead of its roots; keeping in mind that the tree's roots can retain moisture more so than its branches. This favors more long-term usage. Many companies offer special cases for carrying miswak. Many of these companies also produce miswak itself. The main purpose of these cases is to protect and carry miswak in order to preserve its freshness. Plastic toothbrush cases are available at most drug stores and may be used for carrying a Miswak.

One should try to brush the teeth, gums & tongue with it several times a day because our mouth is full of bacterias & most of the bacterias are present in the mouth than other part of our body.

Always try to use fresh & at night keep it in fridge or soak in rose water or plain water. In day time keep it in a case or plastic lock bag so that it is far from getting contaminated. If salvadora persica is not available than one can use olive bark, neem bark etc. But avoid poisonous stem barks; always wash it properly before use; if bad smell is present do not use it always use the once with its normal odour.

Its leaves are bitter & pungent in taste, corrective, deobstruent, astringent to the bowels, tonic to the liver, used in preparation of sauce, and eaten as salad, leaves are diuretic, analgesic, anthelmintic, useful in ozoena and other nose troubles, piles, scabies, leukoderma, reduces inflammation, and strengthening the teeth, scurvy and rheumatism (Khatak M et al.,2010, Farooqi and Srivastava, 1968).

Fruits are sweet and edible; used in fermented drinks, deobstruent, fruits are carminative, diuretic, lithontriptic, and stomachic, biliousness, rheumatism and snake bites. (Khatak M et al., 2010).

Root &Root bark are bitter; used as tooth cleaning stick, it is diuretic, Vesicant, amenorrhea, stimulant, emmenagogue, gonorrhea, vesical catarrh, spleen trouble and general stomach-ache (Khatak M et al.,2010, Abdelrahim and Jurner 1983; Attar, 1979, Kokwaro, 1976, Ezmirly et al., 1979). Stem Bark are bitter & Ascarifuge, and it is helpful in gastric troubles (Khatak M et al., 2010). Seeds are purgative, diuretic and rheumatism (Atassi F., 2002; Bukar A et al., 2004).

- ***Contents/constituents of miswaak(Chemical profile of salvadora persica): -***

It contains vary according to the season.

The major components from the essential oil of the toothbrush tree S. persica stem have been identified as 1,8-cineole (eucalyptol) (46%), a-caryophyllene (13.4%), b-pinene (6.3%), and 9-epi-(E)-caryophyllene.

GC-MS analysis of the volatile oil extracted from S. persica leaves revealed benzyl nitrile, eugenol, thymol, isothymol, eucalyptol, isoterpinolene, and b-caryophyllene as important constituents.
Sticks from S. persica have been analyzed for their soluble and total content of fluoride, calcium, phosphorus, and silica. There was a substantial amount of silica in the ashes of miswak.
The aqueous extract of stem and root of S. persica L. has also been investigated for some antimicrobial anionic components by using capillary electrophoresis techniques. It was reported that the root and stem extracts contain sulfate chloride, thiocynate, and nitrate.

Physicochemical analysis of air-dried root bark of *S. persica* was carried out by Bhandari in 1990. He found that it contains 27.1% ash, consisting of considerable amounts of salts, mostly as chlorides. The drug has large amount of alkloidal constituents (including trimethyl amine and unidentified alkaloids), small amount of resin and coloring matter, and traces of tannins and saponins. Higher concentration of fluoride and silica, sulfur, vitamin C, small amount of flavonoids and sterols were also reported.

Three lignin glycosides have been reported from the stem of *S. persica.* The flavonoids rutin and quercetin were detected in the stem of *S. persica.* Salvadourea has been reported in the root of *S. persica.* Benzylisothiocynate was also isolated from the root. Salvadoricine, a new indole alkaloid, was reported in the leaves of *S. persica*.

Its stem contains octacosanol, 1-triacantanol, β-sitosterol, and β-sitosterol-3-O-β-D-glucopyranoside, and saponin. It is essential oil contained α- and β-thujones, camphor, cineole, β-cymene, limonene, β-myrcene, borneol, linalool, and bornyl acetate and nonvolatile fraction contained humulene, caryophyllene, β-santatol, and farnesol.

It also contains benzylamide; (the isolated compounds were identified as butanediamide, N1, N4-bis (phenylmethyl)-2(S)-hydroxy-butanediamine, *N*-benzyl-benzamide, *N*-benzyl-2-phenylacetamide and benzyl urea.

Many metals are present in the leaf galls like copper, zinc, iron, nickel, manganese, cobalt, lead, cadmium, cerium, vanadium, titanium, molybdenum, mercury it also contains sodium, potassium, calcium.

It also contain following amino acids alanine, arginine, asparagine, aspartic, glutamine, glycine, isoleucine, leucine, proline, valine. It also contains tannins, silica, a small amount of resin, trimethylamine, m-anisic acid, and salvadourea and alkaloidal constituents; also fluoride ions, vitamin C.

Its seed contains myristic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, arachidic acid, eicosenic acid, behanic acid and natural sulphur.

Each content is explained separately below: -

- ***Trimethylamine: -***

Trimethylamine is a tertiary amine that is ammonia in which each hydrogen atom is substituted by a methyl group. It has a role as a human xenobiotic metabolite and an Escherichia coli metabolite. It is a tertiary amine and a member of methylamines. It is a conjugate base of a trimethylammonium.

The absorption, distribution, and biotransformation of TMA ... /was/ followed in rats given intravenous doses of 1 to 2 g/kg. TMA was rapidly distributed to tissues, especially the liver. In rats, TMA was 81% available after oral administration, reached a peak blood level 1 hour after oral administration, and was cleared with a half-life of 2 to 2.5 hours. When fed a synthetic diet, clearance showed a two-fold reduction. Conversion of TMA to its metabolite, trimethylamine-N-oxide, proceeded slowly in liver homogenates. In humans, TMA is formed in the intestinal tract from dietary choline. Large doses of choline result in disproportionately higher formation and urinary excretion of TMA. In newborn dairy calves, fecal trimethylamine levels are clearly higher in milk-fed calves and show huge elevations in diarrheic cases. Although fish is a major source of TMA in the diet, strawberries, kale juice, and garlic have been shown to increase urinary TMA levels. It is an alkaloid that has been used to treat cases of acute articular rheumatism. It is anti-bacterial, anti-phlogistic, gum stimulating etc.

- ***Plant Resin: -***

Resins are plant products are not soluble in water; get harden when exposed to air; do not play a role in the fundamental processes of the plant, and are generally produced by woody plants. Resins are produced in special resin cells in plants, and are also produced when an injury occurs to the plant. Resins can be produced through the bark of a tree, the flowers of an herb, or the buds of a shrub. Resin is a hydrocarbon secretion of many plants, particularly coniferous trees. It is valued for its chemical constituents and uses, such as varnishes and adhesives, as an important source of raw materials for organic synthesis, or for incense and perfume.

- ***Salvadourea: -***

It is a newly invented phytochemical found in salvadora persica (miswaak) & it is under research.

- ***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.

- ***Silica: -***

It is an essential mineral; it is naturally present in vegetables, fruits etc; it is present in our body in a form of orthosilicic acid.

Main sources of silica: -

It is present in cucumber, wheat, onion, flex seed, avocados, banana, green beans, spinach, rice etc.

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

Its absorption, metabolism & excretion are yet not known & are under research. It is very little absorbed in the body & excreted in urine. It is stored in bones, tendons, aorta, liver & kidney.

Basic clinical pharmacology of silica: -

It supports & helps in bone health, connective tissues, skin, nails & hair health. It acts on depositing of minerals in bones thus promote bone health, it also acts as a stabilizer in the body & maintain balance between calcium & magnesium without balance of it we can have hormonal problem. It stabilizes body tissues, membrane, and arterial health. It helps to form collagen in body thus keeps skin health & act on wound healing.

- ***Sulfur: -***

Sulfur is an essential element for all life, but almost always in the form of organo-sulfur compounds or metal sulfides. Three amino acids (cysteine, cystine, and methionine) and two vitamins (biotin and thiamine) are organo-sulfur compounds. Many cofactors also contain sulfur, including glutathione, thioredoxin, and iron–sulfur proteins. Disulfides, S–S bonds, confer mechanical strength and insolubility of the protein keratin, found in outer skin, hair, and feathers. Sulfur is one of the core chemical elements needed for biochemical functioning and is an elemental macronutrient for all living organisms. Sulfur (in British English, sulphur) is a chemical element with the symbol S and atomic number 16. Elemental sulfur is a bright yellow; Sulfur is the third most abundant chemical in the human body. The element is also found in a number of foods such as garlic, onions, eggs, and protein-rich foods. Sulfur is necessary for the synthesis of the essential amino acids cysteine and methionine. It is helpful in osteoarthritis, muscles soreness, hair fall, antibacterial, antiviral, dandruff etc.

- ***Thiocyanate: -***

Thiocyanate (also known as rhodanide) is the anion [SCN]. It is the conjugate base of thiocyanic acid. Common derivatives include the colourless salts potassium thiocyanate and sodium thiocyanate. Organic compounds containing the functional group SCN are also called thiocyanates. Mercury (II) thiocyanate was formerly used in pyrotechnics.

Thiocyanate is analogous to the cyanate ion, $[OCN]^-$, wherein oxygen is replaced by sulfur. $[SCN]^-$ is one of the pseudohalides, due to the similarity of its reactions to that of halide ions. Thiocyanate used to be known as rhodanide (from a Greek word for rose) because of the red colour of its complexes with iron. Thiocyanate is produced by the reaction of elemental sulfur or thiosulfate with cyanide.

- ***Benzyl isothiocyanate: -***

Benzyl isothiocyanate is an isothiocyanate. It has a role as an antibacterial; Benzyl isothiocyanate is a naturally-occurring constituent of cruciferous vegetables. It has antibacterial properties and its metabolism in man has been investigated. It inhibits chemically induced cancer in animal models. Benzyl isothiocyanate and other isothiocyanates in general, were found to be protective against pancreatic carcinogenesis in vitro; a recent published study showed its restraining impact on obesity, fatty liver, and insulin resistance in diet-induced obesity mouse model; it is also present in papaya seeds, pilu oil, water cress etc.

- ***Salvadoricine: -***

Salvadoricine is an indole alkaloid isolated from the leaves of Salvadora persica; Salvadoricine which has been identified as 2-acetyl-3-methylindole (I) on the basis of its spectral studies & confirmed by synthesis. It is a white crystalline compound; it is under research.

- ***1-Triacontanol: -***

1-Triacontanol is a fatty alcohol of the general formula $C_{30}H_{62}O$, also known as melissyl alcohol or myricyl alcohol. It is found in plant cuticle waxes and in beeswax. Triacontanol is a growth stimulant for many plants, most notably roses, in which it rapidly increases the number of basal breaks. 1-Triacontanol or n-triacontanol is a natural plant growth regulator. It has been reported to increase the growth of plants by enhancing the rates of photosynthesis, protein biosynthesis, the transport of nutrients in a plant and enzyme activity, reducing complex carbohydrates among many other purposes. The fatty

alcohol appears to increase the physiological efficiency of plant cells and boost the potential of the cells responsible for the growth and maturity of a plant. It is mostly present in alfalfa leaves & wheat in little quantity. It is under research.

- ***Farnesol: -***

Farnesol is a natural 15-carbon organic compound which is an acyclic sesquiterpene alcohol. Under standard conditions, it is a colorless liquid. It is hydrophobic, and thus insoluble in water, but miscible with oils. Farnesol is produced from 5-carbon isoprene compounds in both plants and animals. Phosphate activated derivatives of farnesol are the building blocks of most, and possibly all, acyclic sesquiterpenoids. These compounds are doubled to form 30-carbon squalene, which in turn is the precursors for steroids in plants, animals, and fungi. As such, farnesol and its derivatives are important starting compounds for both natural and artificial organic synthesis. Farnesol is also present in many essential oils such as citronella, neroli, cyclamen, lemon grass, tuberose, rose, musk, balsam and tolu. It is used in perfumery to emphasize the odors of sweet floral perfumes. Farnesol has been suggested to function as a chemopreventative and anti-tumor agent. Farnesol is used as a deodorant in cosmetic products because of its anti-bacterial activity.

- ***Benzylamide: -***

It is a newly phytochemical investigation of stems from Salvadora persica resulted in the first isolation of four benzylamides from a natural source. The isolated compounds were identified as butanediamide, N1,N4-bis(phenylmethyl)-2(S)-hydroxy-butanediamide, N-benzyl-2-phenylacetamide, N-benzylbenzamide and benzylurea. The structure elucidation was accomplished using spectroscopic methods, especially 2D NMR and HREIMS. Compound 2 revealed a significant inhibitory effect on human collagen-induced platelet aggregation, and a moderate antibacterial activity against Escherichia coli. It is under research.

- ***Beta-sitosterol 3-o-beta-d-glucuronopyranoside: -***

Beta-sitosterol 3-o-beta-d-glucuronopyranoside is a member of the class of compounds known as steroid glucuronide conjugates. Steroid glucuronide conjugates are sterol lipids containing a glucuronide moiety linked to the steroid skeleton. Beta-sitosterol 3-o-beta-d-glucuronopyranoside is practically insoluble (in water) and a weakly acidic compound (based on its pKa). Beta-sitosterol 3-o-beta-d-glucuronopyranoside can be found in a number of food items such as dill, bitter gourd, dandelion, and german camomile, which makes beta-sitosterol 3-o-beta-d-glucuronopyranoside a potential biomarker for the consumption of these food products.

- ***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 hair 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.

- ***Limonene: -***

It is a chemical found in the peel of citrus fruits & other plants; it is used to make medicinal ointments, creams, to facilitate penetrate the skin, & also used in beverages, chewing gums, ready food & used as a flavouring agent.

Main sources of limonene: -

Citrus fruit & its peels, grapes, black caraway seeds, soda drink, citrus peel oil.

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

It is completely absorbed in intestines & there is rapid excretion in urine & little in stools; very less is known about its absorption & metabolism.

Basic clinical pharmacology of limonene: -

It prevent cancers, weight gain, helpful in bronchitis, boost immunity; it is antioxidant, anti-inflammatory, anti tumour, improves gall bladder health, cleans out the sludge in gall bladder; good for skin, boost metabolism, reduces stress, anxiety.

- ***Myrcene (beta myrcene): -***

Myrcene (Beta myrcene) 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.

- ***Myristic acid: -***

It is a common nontoxic long-chain saturated fatty acid; it is also called as tetradecanoic acid; it is water soluble; its salt & esters are commonly referred as myristates.

Main sources of myristic acid: -

It is mainly present in pumpkin seed oil, butter fat, palm kernel oil, coconut water & oil, nutmeg oil etc.

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

Its absorption, metabolism & excretion are under research.

Basic clinical pharmacology of myristic acid: -

It cleans the skin & keeps the skin hydrate, plump & youthful; it is used in beauty products, shaving, soaps, creams, lotions, hair conditioner & personal care products manufacturing.

- ***Palmitic acid: -***

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, pumpkin seed oil, grape seed oil 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 is saturated fatty acid.

Main sources of stearic acid: -

It is mainly present in olive oil, also present in butter, whole milk, yeast bread, egg, pumpkin seed oil, grape seed oil 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.

- ***Eicosenoic acid: -***

Eicosenoic acid may refer to one of three closely related chemical compounds: 9-Eicosenoic acid (gadoleic acid) an omega-11 fatty acid (20:1ω11); 11-Eicosenoic acid (gondoic acid) an omega-9 fatty acid (20:1ω9); 13-Eicosenoic acid (paullinic acid) an omega-7 fatty acid (20:1ω7).Eicosenoic acid is a monounsaturated long chain fatty with 20-carbon backbone and sole double bond originating from 5th, 6th, 7th, 9th, 11th 12th or 15th positions from the methyl end.
Gadoleic acid (20:1 n−11) is an unsaturated fatty acid. It is a prominent component of some fish oils including cod liver oil. It is one of a number of eicosenoic acids.
11-Eicosenoic acid, also called gondoic acid; it is a monounsaturated omega-9 fatty acid found in a variety of plant oils and nuts; in particular jojoba oil. It is one of a number of eicosenoic acids.
Paullinic acid is an omega-7 fatty acid find in a variety of plant sources, including guarana (*Paullinia cupana*) from which it gets its name. It is one of a number of eicosenoic acids.

It is beneficial for skin, nail, bones, hair, heart, liver, Rbc, teeth etc & help in maintaining general health.

- ***Behenic acid: -***

Behenic acid (also docosanoic acid) is a carboxylic acid, the saturated fatty acid with formula $C_{21}H_{43}COOH$. In appearance, it consists of white to cream color crystals or powder with a melting point of 80 °C and boiling point of 306 °C. It is a major component of Ben oil (or behen oil), which is extracted from the seeds of the Ben-oil tree (*Moringa oleifera*), also present in rapeseed (canola) and peanut oil. It is beneficial for skin& hair, maintains moisture & lubricates& hydrates the skin& hair.

- ***Oleic acid: -***

Its short hand notation is C18:1, it is a non-essential (means it is produced naturally in the body) monounsaturated omega 9 fatty acid, It is insoluble in water & soluble in alcohol. It increases absorption of many drugs through skin by disrupting the lipids under the skin and penetration of the drugs, so pumpkin seed oil is best to be used with other applications on skin and used in cosmetic formulas.

Main sources of oleic acid: -

It is present in extra virgin olive oil is the best, also present in avocado oil, camellia oil, shea nut oil, apricot oil, sweet almond oil, whole egg, nuts, argan oil, pumpkin seed oil, grape seed oil etc.

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

It is believed that it is absorbed by different tissues mediated via passive diffusion to facilitate diffusion (this is under research) after taken up by the tissues it is stored in the form of natural triglycerides or oxidized, it is transported by lymphatic system; it is also believed to penetrate through skin (it is under research), its excretion is in stool. It is stored 98% in adipose tissues depots in form of triglycerides. Its metabolism & plasma half-life is yet not known.

Basic clinical pharmacology of oleic acid: -

It increases bioavailability of following medicines cortisol, hydrocortisone, betamethasone, 17 benzoate betamethasone, 17 valerate (betamethasone), ketarolac (anti-inflammatory), metronidazole, progesterone & estradiol. So I advised to mixed powder of prednisolone mixed in extra virgin olive oil and apply on eczema & psoriasis and get good results in cheaper rates.

Oleic acid prevents cardio vascular disease, blood pressure, skin disease, breast cancer, colon cancer, prostate cancer, stomach cancer, diabetes, gall stones, gastrointestinal disease and pancreatic disease. It reduces cholesterol, triglycerides, LDL, inflammation, swelling etc.

- ***Linoleic acid: -***

It is a carboxylic acid, 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, pumpkin seed oil 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.

- ***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.

- ***Anisic acid: -***

Anisic acid is also called as methoxybenzoic acid & methylsalicylic acid; it is an organic compound which is a carboxylic acid. It exists in three forms, depending on arene substitution patterns: *p*-Anisic acid (4-methoxybenzoic acid), *m*-Anisic acid (3-methoxybenzoic acid), *o*-Anisic acid (2-methoxybenzoic acid); it belongs to the class of organic compounds known as m-methoxybenzoic acids and derivatives. These are benzoic acids in which the hydrogen atom at position 3 of the benzene ring is replaced by a methoxy group. 3-Methoxybenzoic acid is an extremely weak basic (essentially neutral) compound (based on its pKa).

- ***Phytosterol: -***

It is plant sterol & stanol esters; it is a group of naturally occurring compound found in plant cell membranes. It is structurally similar to our body's cholesterol & it competes with cholesterol during digestion & blocks absorption of it thus reduces blood cholesterol & is good for heart.

Main sources of phytosterol: -

Vegetable oil, seeds, nuts, grapes, cereals, nuts, legumes etc.

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

It is absorbed only in trace amount only; it inhibits the absorption of intestinal cholesterol & biliary cholesterol.

Basic clinical pharmacology of phytosterol: -

It reduces cholesterol, risk of coronary heart disease, cancer cells growth, prevent diseases, maintain prostate gland health, it is anti-inflammatory, maintain health of nails, hair etc.

- ***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.

- ***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.

- ***Saponin: -***

Saponins are glucosides with foaming characteristics. Saponins consist of a polycyclic aglycones attached to one or more sugar side chains. The aglycone part, which is also called sapogenin, is either steroid (C27) or a triterpene (C30). The foaming ability of saponins is caused by the combination of a hydrophobic (fat-soluble) sapogenin and a hydrophilic (water-soluble) sugar part. Saponins have a bitter taste. Some saponins are toxic and are known as sapotoxin.

Basic clinical pharmacology of saponin: -

It reduces cholesterol, LDL, increases testosterone, libido & muscle mass; it maintain balance between cellular proliferation & cell death the disturbances in the balance cause severe diseases like cancer etc; it is anti-bacterial, anti-oxidant, inhibit tumour growth.

- ***Tannin: -***

It is of astringent (dry & puckery feeling in mouth) taste, it is a polyphenol present in many plants, fruits, plant's wood, bark, leaves, skin, seeds etc. It is also called as Tannic acid; it is of 2 types hydrolysable & condensed. Hydrolysable is decomposable in water & reacts with water & form other substance. Condensed form is insoluble & precipitates, it is called as tanner's reds. But most of tannic acid is water soluble.

Main sources of tannin: -

It is present berries, apple, barley, nut, tea, legumes, grapes, pomegranate, quince, oak wood, lemons, squash etc.

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

Its absorption, metabolism & excretion are yet not known & are under research. After ingestion its bioavailability is poor due to its large size, high affinity to bound to plasma protein & low lipid solubility. It gets hydrolyzed in glucose & release gallic acid & other compounds upon decomposition.

Basic clinical pharmacology of tannin: -

It is used internally & externally. Externally it cures & heals the condition when applied on cold sores, fever blisters, diaper rashes, bleeding gums, tonsillitis, skin rashes, white discharge, yellow discharge, minor burn etc. It is used as douche for virginal disorders like white or yellow discharge.

In food it is used as flavoring agent & naturally present in fruits etc, it relieves & cures chronic diarrhea, dysentery, hematuria (blood in urine), pain in joints, persist cold, cancers etc, it reduces high blood pressure, high lipids in blood. It is anti-aging, anti-oxidant, anti-bacterial, anti-enzymatic. It is used in medicated ointments for piles.

If used excessive it can give toxic effects on skin & internally may reduce absorption of vitamin, cause stomach irritation, nausea, vomiting, liver damage, kidney damage. It should not be used in pregnancy, breast feeding & constipation.

- ***Thymol: -***

It is a natural mono-terpenoid phenol mostly present in thyme plant; it has pleasant aromatic odour, it is anti-hook worm.

Main sources of thymol: -

Thyme oil, eye bright plant (Euphrasia rostkoviana), monarda didyma & origanum compactum.

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

It is readily absorbed in intestines on oral administration; it is essentially excreted in urine within the first 24 hours after absorption.

Basic clinical pharmacology of thymol: -

It reliefs headache, diarrhea; it is anti-cancer, anti-septic, anti-inflammatory, antioxidant, anti-fungal, anti-spasmodic, anti-bacterial, prevent free radical, cardio vascular disease, it is analgesic, reduces lipids, treat pain & neurological diseases.

- ***Eugenol:-***

It is member of allybenzene class compound. It is colourless or pale yellow aromatic oily liquid extracted from many essential oil like cinnamon, clove oil, nutmeg, basil, bay leaf, marjoram, clove-bud oil, clove leave oil. It has pleasant, spicy, clove like aroma. It is used in perfumes & flavorings; it is antiseptic, anaesthetic, reduces pain & induces sleep.

- ***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.

- ***Caryophyllene: -***

It is a natural bicyclic sesquiterpene present in many essential oils like clove oil (syzygium aromaticum stem & flower oil), cannabis sativa oil, rosemary oil, hops oil, basil oil, lavender oil, cinnamon oil, black caraway, thyme oil. It is anti-inflammatory, analgesic, prevents arthrosclerosis, osteoporosis, colitis, osteoarthritis, diabetes, cerebral ischemia, anxiety, depression, liver fibrosis, anti-cancer. Its absorption & metabolism is not known.

- ***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. Beta-caryophyllene is a pale yellow oily liquid with an odor midway between odor of cloves and turpentine. It is usually found as a mixture with isocaryophyllene (the *cis* double bond isomer) and α-humulene (obsolete name: α-caryophyllene), a ring-opened isomer. Caryophyllene is notable for having a cyclobutane ring, as well as a *trans*-double bond in a 9-membered ring, both rarities in nature.

- ***Alpha-caryophyllene: -***

It is also known as Humulene; 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.

- ***9-epi-(E)-caryophyllene: -***

9-epi-beta-caryophyllene is a sesquiterpene with a [7.2.0]-bicyclic structure comprising fused 9- and 4-membered rings, with a cis-ring junction, a methylidene group at position 9, and methyl groups at positions 3, 11, and 11. It has a role as a metabolite. It is a sesquiterpene and an ortho-fused bicyclic hydrocarbon.

- ***Thujone: -***

It is a ketone & mono-terpene that occurs naturally in two forms alpha & beta; it has a menthol odour; it acts on GABA as an antagonist (opposite to the effects of alcohol); it is used in perfumes; it is present in thyme oil, arborvitae, nootka cypress, oregano, common sage, tansy, worm-wood. In high & toxic dose it is convulsant & neuro-toxic. Its absorption, metabolism is not known & is under research.

- ***Natural camphor: -***

Natural camphor is derived from the sap of an evergreen tree the camphor laurel, other laurels, and rosemary, the common kitchen herb. Synthetic camphor is derived from the sap (turpentine) of evergreen trees in the pine family. Camphor (topical) suggested uses include treating pain, warts, cold sores, hemorrhoids, osteoarthritis, anti-itch, to increase local blood flow, and as a counterirritant. Camphor is an FDA-approved topical antitussive (anti-cough). Camphor is an FDA-approved topical analgesic and anesthetic used to relieve pain.

- ***1.8-cineole: -***

1.8-cineole is a natural monoterpene, also known as eucalyptol. It is a major compound of many plant essential oils, mainly extracted from Eucalyptus globulus oil. As an isolated compound, 1.8-cineole is known for its mucolytic and spasmolytic action on the respiratory tract, with proven clinical efficacy. 1.8-cineole has also shown therapeutic benefits in inflammatory airway diseases, such as asthma and chronic obstructive pulmonary disease (COPD).

- ***Cineole: -***

It is mono-terpene ether present in essential oils & used in fragrance, flavoring, medicines, cough drops, personal care products, used as expectorant, anti-septic. It is main constituent of eucalyptus oil; it is colourless, oil, slightly soluble in water. It has camphor like odour & pungent spicy cooling taste; it is also called as eucalyptol; it is anti-inflammatory, anti-viral, antioxidant, anti-spasmodic, increase cerebral blood flow, anti-fungal, immune-regulator, helpful in sinusitis, asthma, acute & chronic bronchitis, sore throat, laryngitis, herpes simplex, acne, measles, chicken pox, ulcers, wounds, boils cuts, burns; it is mucolytic, analgesic, clears the airway. It is present in sweet basil oil, common sage, bay leaves, camphor laurel, tea tree, worm-hood, moonwort, rosemary, thyme oil, cannabis sativa. Its absorption & metabolism is not known.

- ***Carvacrol (isothymol): -***

It is a mono-terpenoid phenol; it has a pungent, warm odour of oregano, it is also called as cymophenol. It is present in thyme oil, oregano, pepperwort, wild bergamot. It helps in curing candida infection & yeast infections; it is anti-cancer, anti-bacterial, antioxidant, anti-inflammatory, reduces blood pressure, improves gut health; heals wounds etc. it is an active principle of oregano oil. Its absorption, metabolism in human is yet not known.

- ***Isoterpinolene: -***

Isoterpinolene 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.

- ***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.

- ***Borneol: -***

It is a bicyclic organic compound and a terpene derivative; it is naturally found in two forms enantiomers (opposite or mirror image) as d & I. It aids the digestive system by stimulating the production of gastric juices, tone of heart, improves circulation; treats bronchitis, cough & cold; can relieve pain cause by rheumatic diseases & sprains; reduces swelling, relives stress. It is under research.

- ***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.

- **β-*Santalol: -***

β-Santalol is an organic compound that is classified as a sesquiterpene; it is found in ginger; it is a flavouring ingredient; it is a constituent of sandalwood oil (Santalum album).

- ***Bornyl acetate: -***

Bornylacetate is a chemical compound. Its molecular formula is $C_{12}H_{20}O_2$ and its molecular weight is 196.29 g/mol. It is the acetate ester of borneol. It is used as a food additive, flavouring agent, and odour agent. It is a component of the essential oil from pine needles (from the family Pinaceae) and primarily responsible for its odour.

- ***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.

- ***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.

- ***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, chili, 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.

- ***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.

- ***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.

- ***Nickel: -***

Nickel is a micro-nutrient essential for proper functioning of the human body, as it increases hormonal activity and is involved in lipid metabolism. This metal makes its way to the human body through respiratory tract, digestive system and skin. Nickel is recognized as the seventeenth element essential for plant growth and development (Liu 2001). Plants requirement of nickel is the lowest of all essential elements at < 0.5 mg per kg of dry weight, making it an essential plant micronutrient.

- ***Lead: -***

Lead is a chemical element with the symbol Pb (from the Latin *plumbum*) and atomic number 82. It is a heavy metal that is denser than most common materials. Lead is soft and malleable, and also has a relatively low melting point. When freshly cut, lead is silvery with a hint of blue; it tarnishes to a dull gray color when exposed to air. Lead has the highest atomic number of any stable element and three of its isotopes are endpoints of major nuclear decay chains of heavier elements. Natural lead consists of four stable isotopes with mass numbers of 204, 206, 207, and 208,and traces of five short-lived radioisotopes. Lead (Pb) exists in many forms in the natural sources throughout the world and is now one of the most widely and evenly distributed trace metals. Soil and plants can be contaminated by lead from car exhaust, dust, and gases from various industrial sources.

- ***Cadmium: -***

Cadmium is a chemical element with the symbol Cd and atomic number 48. This soft, silvery-white metal is chemically similar to the two other stable metals in group 12, zinc and mercury. Like zinc, it demonstrates oxidation state +2 in most of its compounds, and like mercury, it has a lower melting point than the transition metals in groups 3 through 11. Complexes based on heavy metals have great potential for the treatment of a wide variety of cancers but their use is often limited due to toxic side effects. However, scientist are advancing on the field and new promising cadmium complex compounds with reduced toxicity have been discovered.

- ***Cerium: -***

Cerium is a chemical element with the symbol Ce and atomic number 58. Cerium is a soft, ductile and silvery-white metal that tarnishes when exposed to air, and it is soft enough to be cut with a knife. Cerium has no biological role in humans and is not very toxic. Cerium nitrate is an effective topical antimicrobial treatment for third-degree burns although large doses can lead to cerium poisoning.

- ***Vanadium: -***

Vanadium is a chemical element with the symbol V and atomic number 23. It is a hard, silvery-grey, malleable transition metal. The elemental metal is rarely found in nature.

- ***Titanium: -***

Titanium is a chemical element with the symbol Ti and atomic number 22. It is a lustrous transition metal with a silver color, low density, and high strength. Titanium is resistant to corrosion in sea water, aqua regia, and chlorine. It is a strong metal with low density that is quite ductile (especially in an oxygen-free environment), lustrous, and metallic-white in colour; it is non-magnetic and a poor conductor of heat and electricity. Because titanium is biocompatible (non-toxic and not rejected by the body), it has many medical uses, including surgical implements and implants, such as hip balls and sockets (joint replacement) and dental implants that can stay in place for up to 20 years.

- ***Mercury: -***

Mercury is a chemical element with the symbol Hg and atomic number 80. It is commonly known as quicksilver and was formerly named hydrargyrum. A heavy, silvery d-block element, mercury is the only metallic element that is liquid at standard conditions for temperature and pressure; the other element that is liquid under these conditions is halogen bromine, though metals such as caesium, gallium, and rubidium melt just above room temperature. Mercury dissolves many metals such as gold and silver to form amalgams. There are seven stable isotopes of mercury. Mercury and its compounds have been used in medicine, although they are much less common today than they once were, now that the toxic effects of mercury and its compounds are more widely understood.

- ***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 abs

- ***Molybdenum: -***

Its symbol is Mo & atomic no. 42, it is an essential mineral needed by the body in little amount, it is a key component of many vital functions of the body, without it deadly sulfites & other toxins build up in the body, it acts a cofactor for important enzymes & act on breakdown of proteins. It is absorbed in stomach & intestine & metabolized in liver, much detail is yet not known about its digestion in the human body. It is stored in liver, kidney; little is stored in bones, glands, lungs, spleen & skin. It is excreted in urine.

Main sources of molybdenum: -

It is present in milk, cheese, cucumber, beans, lentils, grains, leafy vegetables etc.

Basic clinical pharmacology of molybdenum: -

It prevents esophageal cancer, liver diseases, yeast infections, Lyme disease, allergies, asthma, acne, anemia, gouts & many other diseases.

- ***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: -

It is present in 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.

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.

- ***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.

- ***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

- ***Alanine: -***

It is a non-essential amino acids that is present in blood plasma in its free state in high levels; it is involved in sugar & acid metabolism, protein synthesis, it increases immunity, provides energy for muscles tissues, brain & CNS, it act on tryptophan, vitamin B6 metabolism; it is an important sources of energy for muscles; it helps the body to convert simple sugar (glucose) into energy; it is produced in the body. It increases exercise capacity; reduces muscle fatigue, boost immunity, it is antioxidant; anti-aging; increases muscle growth; ideal pre & post workout, reduce blood sugar, prevent liver disease, helps the liver to eliminate toxins, improves CNS functioning, helpful in benign prostate hypertrophy. It is digested in small intestine; it is converted into pyruvic acid by alanine aminotransferase-1; during fasting condition alanine derived from protein breakdown is converted into pyruvate & used to synthesis glucose by gluconeogenesis in liver, it is excreted in urine via urea cycle. It is stored little in skeletal muscles.

Main sources of alanine: -

Meat, fish, egg, milk, aleovera, honey, black seeds, nuts etc.

- ***Aspartic acid: -***

It is a non-essential amino acid; it is over all negatively charged & plays an important role in synthesis of other amino acid, citric acid & urea cycles; it is found in animals, plants, sugarcane, sugarbeet. It may be a neurotransmitter; it strengthens the muscles, improves heart function, helps in maintaining mental health, reduces tiredness, improves athletic performance, increases muscle size, reduces depression & fatigue. It is absorbed in small intestine by active transport.

Main sources of aspartic acid: -

Meat, oysters, seeds, oats, avocado, sugar beet, milk, egg, nuts, cereals etc.

- ***Glycine: -***

It is a nonessential amino acid that body needs for growth & maintenance of tissue & need to prepare hormones & enzymes. It is inhibitory neurotransmitter. It helps in preparing glutathione (a powerful antioxidant & reduces free radicals, delay aging). It is helpful in preparing of creatine (provides energy to muscles to perform exercise etc & acts on muscle contraction), beneficial for brain health, bone health, alzheimer's, schizophrenia, sleep disorder, stroke, burns, protects kidney & liver from harmful side effects of drugs used after organ transplant, heals wound & ulcers, it is anti-inflammatory, improves skin health.

Main sources of glycine: -

Meat, fish, milk, legumes etc.

- ***Proline: -***

It is a protein-genic amino acid used in biosynthesis of proteins. It heals cartilages, cushion joints, tendons, ligament, heart muscles, connective tissues & helps in formation of collagen.

Main sources of proline: -

Soy, pumpkin seed, lentils, black beans, quinoa etc.

- ***Glutamic acid: -***

It is a nonessential amino acid. It is an excitatory neuro-transmitter; it is necessary for biosynthesis of proteins; body uses it for several key functions within the body like making other neuro-transmitters such as GABA; it promotes brain health, muscles health, intelligence, mood & mental alertness. It is called as chemical messenger. It plays an important role in body's disposal of excessive waste like nitrogen. It is absorbed in lumen of small intestine into enterocytes by active transport & excreted in urine mainly. It is almost about 2 kgs, storage in natural form in brain, kidneys, liver, muscles etc.

Main sources of glutamic acid: -

Meat, chicken, fish, egg, milk, wheat, mushroom, soy, broccoli, walnut, peas etc.

- ***Asparagine: -***

It is a non-essential amino acid; it acts on biosynthesis of proteins; it is a nontoxic carrier of residual ammonia to be eliminated from the body; it acts as diuretic also; it helps cell, nerve, brain to function. It is helpful to nervous system, reduces fatigue, helps in building muscles, improves liver function, protects liver, beneficial for nerve cells & brain; increases stamina, help in synthesis of various enzymes, proteins, glycoprotein etc.

Main sources of asparagine: -

Milk, meat, egg, fish, soy, potato, legumes, nuts, seeds etc.

- ***Arginine: -***

It is among conditional essential amino acid the body needs to function properly; it is made in liver; it plays an important role in building protein thus helpful in body building.

Main sources of arginine: -

Chicken, pumpkin seeds, spirulina, dairy products, red meat, fish, egg etc.

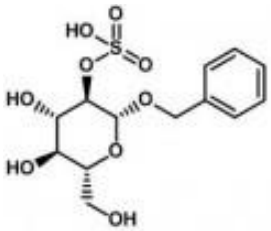
Basic pharmacokinetics of arginine (based on human intake in natural food products): -

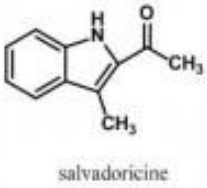
It is absorbed in jejunum mainly from oral diet.

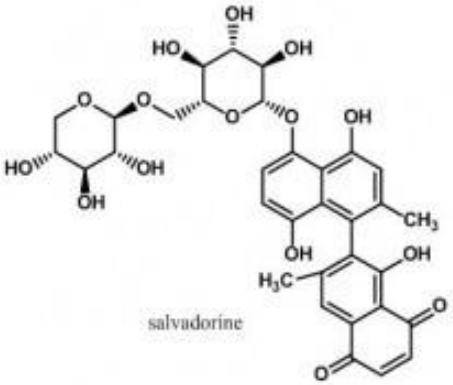
Basic clinical pharmacology of arginine: -

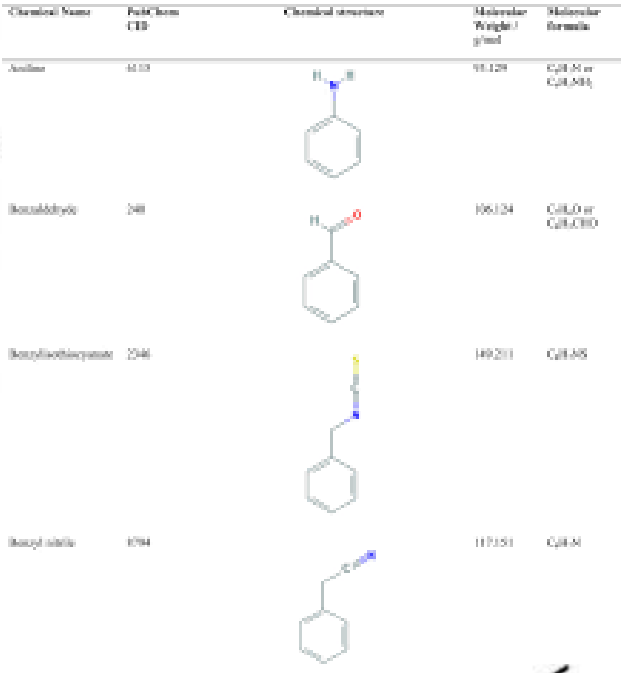
It releases nitric oxide in the blood & nitric oxide dilates the blood vessels thus increases the blood supply & controls high blood pressure, it improves erection, builds muscles etc. it also act on release of growth hormone, insulin & other substances in the body. It also improves heart health, athletes performance, stimulates immune system; citrulline present in watermelon is converted into arginine in kidneys, please refer lesson on watermelon.

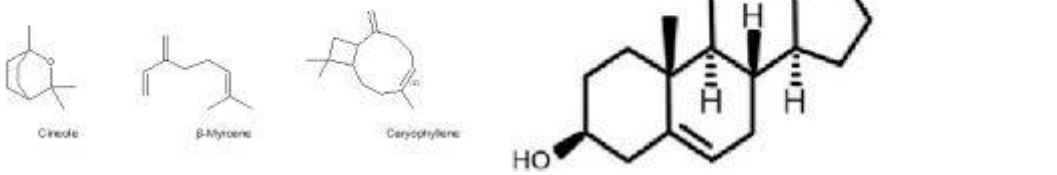
- ***Main chemical structures of salvadora persica: -***











- ***References***

^ Ra'ed I. Al Sadhan, Khalid Almas (1999). "Miswak (chewing Stick): A Cultural And Scientific Heritage". Saudi Dental Journal. 11 (2): 80–88.
^ Al lafi T, Ababneh H (1995). "The effect of the extract of the miswak (chewing sticks) used in Jordan and the Middle East on oral bacteria". International Dental Journal. 45 (3): 218–222. PMID 7558361.
^ "Darout, Ismail Abbas, Undersøkelse av en aktuell eldgammel munnrengjøringsmetode, dr.odont., disputas: 23.06.2003". www.uib.no (in Norwegian). Archived from the originalon 2011-06-05. Retrieved 2006-04-11.
^ Darout, Ismail A.; Albandar, Jasim M.; Skaug, Nils (January 2000). "Periodontal status of adult Sudanese habitual users of miswak chewing sticks or toothbrushes". Acta Odontologica Scandinavica. 58 (1): 25–30. doi:10.1080/000163500429398. PMID 10809396.
^ al-Khateeb TL, O'Mullane DM, Whelton H, Sulaiman MI (2003). "Periodontal treatment needs among Saudi Arabian adults and their relationship to the use of the Miswak". Community Dental Health. 8 (4): 323–328. ISSN 0265-539X. PMID 1790476.
^ Alfadaly, N., Kassab, A., & Al Hedaithy, F. (2016). Determination of DNA profiling of siwak and toothbrush samples used in Kingdom of Saudi Arabia. Egyptian Journal of Medical Human Genetics, 17(4), 383-387.
^ Jump up to:[a] [b] Almas, K; Skaug, N; Ahmad, I. (February 2005). "An in vitro antimicrobial comparison of miswak extract with commercially available non-alcohol mouthrinses". Int J Dent Hyg. 3(1): 18–24. doi:10.1111/j.1601-5037.2004.00111.x. PMID 16451373.
^ Commissioner, Office of the. "Consumer Updates - 5 Things to Know About Triclosan". www.fda.gov. Retrieved 2017-09-23.
^ Commissioner, Office of the. "Safety Alerts for Human Medical Products - Chlorhexidine Gluconate: Drug Safety Communication - Rare But Serious Allergic Reactions". www.fda.gov. Retrieved 2017-09-23.
^ "الرئيسة - الحديث - موقع الإسلام". hadith.al-islam.com.
^ "Excellence of Miswak in Hadiths" at ziaetaiba.com.
^ "Miswak" at sunnah.com.
^ "Siwak" at searchtruth.com.
^ Jump up to:[a] [b] [c] IslamKotob, Muslims and "Science", (Islamic Books), p.30.
^ Farouk, Muhammed. "Miswak/Sewak". www.islam.tc. Archived from the original on 2010-12-22. Retrieved 2006-02-15.
Ronse De Craene L, Wanntorp L. Floral development and anatomy of Salvadoraceae. Ann Bot. 2009;104:913–23. [PMC free article] [PubMed] [Google Scholar]
Sadhan AL, Almas Miswak (chewing stick) - A cultural and scientific heritage. Saudi Dent J. 1999;11:81. [Google Scholar]
Farooqui MI, Srevastava JG. The toothbrush tree (Salvadora persica) Quart J Crude Drug Res. 1968;8:1297–9. [Google Scholar]
Amro SO, Hatem EA, Batwa M. Oral hygiene and periodontal status associated with the use of miswak or toothbrush among Saudi adult population" Cairo Dent J. 2000;23:159–66. [Google Scholar]
Almas K, Albaker A, Felembam N. Knowledge of dental health and diseases among dental patients, a multicentre study in Saudi Arabia. Indian J Dent Res. 2000;11:145–55. [PubMed] [Google Scholar]
Alshammary SF. Effect of saline irrigation on growth characteristics and mineral composition of two local halophytes under Saudi environmental conditions. Pak J Biol Sci. 2008;11:216–21. [PubMed] [Google Scholar]
Batwa M, Bergström J, Batwa S, Meshari F, Al-Otaibi M. Significance of chewing sticks (miswak) in oral hygiene from a pharmacological view-point. Saudi Dental Journal. 2006;18:125–33. [Google Scholar]
Ahmed ES. Preliminary phytochemical and propagation trial with Salvadora persica. Agric Forestry Res. 2008;58:135–8. [Google Scholar]
Atassi F. Oral home care and the reasons for seeking dental care by individuals on renal dialysis. J Contemp Dent Pract. 2002;3:31–41. [PubMed] [Google Scholar]

Bukar A, Danfillo IS, Adeleke OA, Ogunbodede EO. Traditional oral health practices among Kanuri women of Borno State, Nigeria. Odontostomatol Trop. 2004;27:25–31. [PubMed] [Google Scholar]
Jain M, Saxena VK. Chemical constituents of the Stem of Salvadora persica. Acta Ciencia Indica. 1984;10:127. [Google Scholar]
Almas K. The effects of extracts of chewing sticks (Salvadora persica) on healthy and periodontally involved human dentine: a SEM study. Indian J Dent Res. 2001;12:127–32. [PubMed] [Google Scholar]
Almas K. The antimicrobial effects of extracts of Azadirachta indica (Neem) and Salvadora persica (Arak) chewing sticks. Indian J Dent Res. 1999;10:23–6. [PubMed] [Google Scholar]
Al-Otaibi M. The miswak (chewing stick) and oral health. Studies on oral hygiene practices of urban Saudi Arabians. Swed Dent J Suppl. 2004;167:2–75. [PubMed] [Google Scholar]
Hyson JM. History of the toothbrush. J Hist Dent. 2003;51:73–80. [PubMed] [Google Scholar]
Khalil AT. Benzylamides from Salvadora persica. Arch Pharm Res. 2006;29:952–6. [PubMed] [Google Scholar]
Raj KP, Agarwal YK. Heavy metal contents of the leaf-gall. Sci Cult. 1979;45:35. [Google Scholar]
Almas K. The antimicrobial effects of seven different types of Asian chewing sticks. Odontostomatol Trop. 2001;24:17–20. [PubMed] [Google Scholar]
Maggio A, Reddy MP, Joly RJ. Leaf gas exchange and solute accumulation in the halophyte Salvadora persica grown at moderate salinity. Environ Exp Bot. 2000;44:31–8. [PubMed] [Google Scholar]
Quinlan R, Robson G, Pack AR. A study comparing the efficacy of a toothpaste containing extract of Salvadora persica with a standard fluoride toothpaste. J N Z Soc Periodontol. 1994;77:7–14. [PubMed] [Google Scholar]
Joshi AJ, Krishan MK, Mali BS. Seasonal changes in proteins, amino acids and minerals in Salvadora persica with reference to saline habitats. Indian J. Plant Physiol. 1993;17:202–4. [Google Scholar]
Galati EM, Monforte MT, Forestieri AM, Miceli N, Bader A, Trovato A. Salvadora persica hypolipidemic activity on experimental hypercholesterolemia in rat. Phytomedicine. 1999;6:181–5. [PubMed] [Google Scholar]
Sanogo R, Monforte MT, Daquino A, Rossitto A, Maur DD, Galati EM. Antiulcer activity of Salvadora persica structural modifications. Phytomedicine. 1999;6:363–6. [PubMed] [Google Scholar]
Monforte MT, Trovato A, Rossitto A, Forestieri AM, Daquino A, Miceli N, et al. anticonvulsant and sedative effects of Salvadora persica stem extracts. Phytother Res. 2002;16:395–7. [PubMed] [Google Scholar]
Darmani H, Al-Hiyasat AS, E1betieha AM, Alkofahi A. The effect of an extract of Salvadora persica (Meswak chewing stick) on fertility of male and female mice. PhytoMedicine. 2003;10:63–5. [PubMed] [Google Scholar]
Almas K. Miswak (chewing stick) and its oral health. Postgrad Dentist. 1993;3:214. [Google Scholar]
Edi MA, Selim HA. Retrospecitve study on the relationship between Miswak chewing stick and periodontal health. Egyptian Dent J. 1994;40:589–92. [PubMed] [Google Scholar]
Amin TT, Al-Abad BM. Oral hygiene practices, dental knowledge, dietary habits and their relation to caries ong male primary school children in Al Hassa, Saudi Arabia. Int J Dent Hyg. 2008;6:361–70. [PubMed] [Google Scholar]
Darout IA, Albandar JM, Skaug N. Periodontal status of adult Sudanese habitual users of miswak chewing sticks or toothbrushes. Acta Odontol Scand. 2000;58:25–30. [PubMed] [Google Scholar]
Darmine H, Nusayr T, Al-Hiyasat AS. The effects of extracts of Salvadora persica also examined on proliferation Balb/C 3T3 of fibroblast and viability of carcinogenic bacteria. 2006;4:62–6. [Google Scholar]
Almas K, Al-Zeid Z. The immediate antimicrobial effect of a toothbrush and miswak on cariogenic bacteria: a clinical study. J Contemp Dent Pract. 2004;5:105–14. [PubMed] [Google Scholar]
Almas K, Al -Bagieh N, Akpata ES. In Vitro antibacterial effect of freshly cut 1-month-old Miswak extracts. Biomed Lett. 1997;56:145–9. [Google Scholar]
Al-Bagieh N, Almas K. In-vitro antibacterial effects of aqueous and alcohol extracts of Miswak (chewing sticks) Cairo Dent J. 1997;13:221–4. [Google Scholar]
Baeshen HA, Kjellberg H, Lingstr AP, Birkhed D. Uptake and release of fluoride from Fluoride-impregnated chewing sticks in vitro and in vivo. Caries Res. 2008;42:363–8. [PubMed] [Google Scholar]
Kubota K, Tanaka T, Murata Y, Hirasawa M. Effect of tannic acid on adherence of Candida to denture base. J Dent Res. 1988;67:183. [Google Scholar]
Norton MR, Addy M. Chewing sticks versus tooth brushes in west Africa. Clin Prev Dent. 1989;11:11–3. [PubMed] [Google Scholar]
Abo Al-Samh D, Al-Bagieh N. A Study of antibacterial activity of the miswak extract in vitro. Biomed lett. 1996;53:225–38. [Google Scholar]
Almas K, Skaug N, Ahmad I. In vitro antimicrobial comparison of miswak extract with commercially available non-alcohol mouthrinses. Int J Dent Hyg. 2005;3:18–24. [PubMed] [Google Scholar]
Tubaishat RS, Darby ML, Bauman DB, Box CE. Use of miswak versus toothbrushes: oral health beliefs and behaviors among a sample of Jordanian adults. Int J Dent Hyg. 2005;3:126–36. [PubMed] [Google Scholar]
Al-Otaibi M, Al-Harthy M, Gustafsson A, Angmar B. Comparative effect of chewing sticks and tooth brushing on plaque removal and gingival health. Oral Health Prev Dent. 2003;1:301–7. [PubMed] [Google Scholar]
Sofrata AH, Claesson RL, Lingstram PK, Gustafsson AK. Strong antibacterial effect of miswak against oral microorganisms associated with periodontitis and caries. J Periodontol. 2008;79:1474–9. [PubMed] [Google Scholar]
Khan MK, Khan AA, Hosein T, Mudassir A, Mirza KM, Anwar AJ. Comparison of the plaque-removing efficacy of toothpaste and toothpowder. Int Acad Periodontol. 2009;11:147–50. [PubMed] [Google Scholar]
Al-Otaibi M, Angmar B. Oral hygiene habits and oral health awareness among urban Saudi Arabians. Oral Health Prev Dent. 2004;2:389–96. [PubMed] [Google Scholar]
Al-Otaibi M, Al-Harthy M, Gustafsson A, Johansson A, Claesson R, Angmar-B Subgingival plaque microbiota in Saudi Arabians after use of miswak chewing stick and toothbrush. J Clin Periodontol. 2004;31:1048–53. [PubMed] [Google Scholar]

- ***Research: -***

Dental plaques mainly composed of various aerobic and anaerobic bacteria; it is the main etiological agent for initiation and progression of periodontal disease. Certain species, such as *A. actinomycetemcomitans, P. gingivalis, Prevotella intermedia*, and *Treponema denticola*, are more commonly associated with destructive periodontal disease.

It has been found that the bacteria cultivated from healthy sites consist predominantly of Gram-positive facultative rods and cocci (approximately 75%). The recovery of this group of microorganisms is decreased proportionally in gingivitis (44%) and periodontitis (10 to 13%). These diseases are accompanied by an increase in the proportion of Gram-negative rods, from 13% in health to 40% in gingivitis and 74% in advanced periodontitis.

Al-Lafi and Ababneh in 1995 reported that the use of miswak inhibits the formation of dental plaque chemically and also exerts antimicrobial effect against many micro-organisms. Later on, Almas and Al-Bagieh in their *in vitro* study demonstrated that aqueous extract of miswak has growth-inhibitor effect on several microorganisms.

In 2002, Darout *et al*. used checker board DNA-DNA hybridization and stated that miswak has selective inhibitory effect on salivary bacteria. They found that there were significantly higher levels of *A. actinomycetemcomitans, Prevotella melaninogenica, Campylobacter rectus, Peptostreptococcus micros, Veillonella parvula, S. mutans, Streptococcus anginosus,*

Actinomyces israelii, Capnocytophaga sputigena, and *P. gingivalis*, and significantly lower levels of *P. intermedia, Fusobacterium nucleatum, C. sputigena, Eikenella corrodens, L. acidophilus, Streptococcus sanguis, Streptococcus salivarius, Streptococcus oralis*, and *Streptococcus mitis* in the miswak than in the toothbrush group. But, Al-Otaibi M *et al*. observed that the use of miswak, in contrast to toothbrush, significantly reduced the amount of *A. actinomycetemcomitans* in the subgingival plaque, which indicated that extracts from *Salvadora persica* might interfere with the growth and leuco-toxicity of A. actinomycetemcomitans. The difference in results of these two studies could be explained on the basis of the different study design.

Benzyl isothiocyanate, a major component of *Salvadora persica*, exhibited rapid and strong bactericidal effect against oral pathogens involved in periodontal disease as well as against other Gram-negative bacteria, while Gram-positive bacteria mainly displayed growth inhibition or remained unaffected.

Mansour MI *et al*. compared the bactericidal activity of alcoholic and aqueous extract of miswak and found that alcoholic extract was more bactericidal than aqueous extract.

Almas K *et al*. assessed the anti-microbial activity of eight commercially available mouth rinses (Corsodyl, Alprox, Oral B advantage, Florosept, Sensodyne, Aquafresh mint, Betadine, and Emoform) and 50% miswak extract against several microorganisms. It was observed that mouth rinse containing Chlorhexidine had maximum anti-bacterial activity while Cetylpyridinium chloride mouth rinse was with moderate and miswak extract was with low anti-bacterial activity.

A 2016 paper has been published comparing human DNA left on used miswak and toothbrushes, including the effect of time, to determine whether miswak is a reasonable source of DNA when found at crime scenes. The conclusion was that miswak contains a high enough quantity of DNA, and retained good DNA profiling; and when compared to toothbrushes, miswak is a reasonable source of DNA for forensic profiling. In addition, time of storage up to 4 months had no or little effects on results.

Studies indicate that Salvadora persica extract exhibits low antimicrobial activity compared to other oral disinfectants and anti-plaque agents like triclosan and chlorhexidine gluconate.

Mouth rinses containing chlorhexidine was with maximum antibacterial activity, while cetylpyridinium chloride mouth rinses were with moderate and miswak extract was with low antibacterial activity.

However, the benefits of triclosan were discounted by the United States Food and Drug Administration in 2016 and its safety is uncertain as a hygiene product ingredient. Chlorhexidine gluconate was also linked to serious allergic reactions, albeit rarely.

Toothbrushes vs miswak in oral health

Bristle toothbrush, which is the most common and widely used aid for oral hygiene, was first time patented in America in 1887 and has since then undergone little change. The American Dental Association has described the range of dimensions of acceptable brushes: a brushing surface 1 to 1.25 inches (25.4 to 31.8mm long) and 5/10 to 3/8 inch (7.9 to 9.8 mm) wide, 2 to 4 rows of bristles, and 5 to 12 tufts per row. The diameter of commonly used bristles ranges from 0.0071 inches (0.2 mm) for soft brushes to 0.012 inches (0.3 mm) for medium brushes and 0.014 inches (0.4 mm) for hard brushes.

These tooth brushes are usually used with dentifrices which aid in cleaning and polishing the tooth surfaces.

Dentrifices are commonly available in the form of tooth pastes, tooth powders and gels. Dentifrices are made up of polishing/abrasive agents (calcium carbonate, silicon oxides, aluminium oxide etc.), binding/thickening agents (carrageenates, alginates, sodium carboxymethyl cellulose, colloidal silica etc.), detergents/surfactants (sodium lauryl sulphate), humectants (sorbitol, glycerine, polyethylene glycol etc.), antibacterial agents (triclosan, metallic ions, Zn citrate trihydrate, delmopinol etc.), flavouring agents (peppermint/spearmint oil) and therapeutic agents (as fluoride and pyrophosphates).

Most of the studies discussing the efficacy of miswak and modern tooth brush have shown a superior or comparable effect of miswak over the use of tooth brushes. Danielsen B *et al*. compared the efficacy of miswak and use of tooth brush and they found that the use of miswak was associated with a significant reduction of dental plaque and gingivitis along with comparable or superior oral hygiene effect.

Gazi *et al*. compared the periodontal status of habitual miswak and toothbrush users and showed that the former had lower gingival bleeding and interproximal bone height than the toothbrush users. They also suggested that 5 times a day use of miswak might offer a suitable alternate for tooth brushing in reducing plaque and gingivitis. However, Eid *et al*. reported that there no significant differences in gingival or bleeding indices between miswak and modern toothbrush users. Sote EO also did not find any difference in plaque and gingival bleeding in chewing stick and toothbrush users.

Darout IA *et al*. conducted a study on 213 males, aged 20 to 65 years, to evaluate the periodontal status of miswak and toothbrush users. They reported that periodontal status of miswak users in Sudanese population is better than that of toothbrush. In a single-blind cross-over clinical study, after professional instruction of the proper use of miswak and toothbrush, miswak was found to be more effective than use of tooth brush for reducing plaque and gingivitis in a sample of male Saudi Arabians.

Although both miswak and toothbrush serve similar function, they vary in their design. Unlike a conventional toothbrush, the bristles of the Miswak lie in the same long axis as its handle. Consequently, the facial surfaces of the teeth can be reached more easily than the lingual surfaces or the interdental spaces. The angulation in the toothbrush enables it to adapt more easily to the distal tooth surfaces, particularly on the posterior teeth.

Two basic holds for miswak: pen-grip (three finger grip) and the palm-grip (five finger grip) have been documented in literature. In each case, the aim is to ensure firm but controlled movement of the brush end of the Miswak within the oral cavity, so that every area of the mouth is reached with relative ease and convenience. The basic technique employed for removing plaque mechanically are similar to that for toothbrush and the chewing stick, i.e., vertical and horizontal brushing. The cleaning

movement should always be directed away from the gingival margin of the teeth (away from the gums) on both the buccal and lingual surfaces.

Miswak chewing sticks have been found to be associated with high level of gingival recession and tooth wear. Eid MA *et al*. reported high level of gingival recession in Miswak chewing stick users. These findings could be explained on the basis of high frequency per day (5 times per day) and uninstructed manner of use of miswak. However, Johansson et al. correlated miswak use with high level of tooth wear. But despite these side effects, this traditional oral hygiene practice is so common in our population that it needs further investigations on modern scientific lines.

- ***Conclusion: -***

Meticulous plaque control on a daily routine basis is the single most important step to achieve good oral health. Herbal chewing sticks, commonly known as Miswak, are among the ancient and traditional oral hygiene aids popular in India, Pakistan, most of the Arabian countries, and several African countries. But nowadays, because of low cost, free availability, unique chemical composition, and spiritual beliefs, miswak is being used worldwide. A large number of studies have proved that miswak is as effective as, or even superior to the present day's most common oral hygiene aid, i.e., toothbrush. The aim of this review article is to discuss various pharmacological and therapeutic aspects of miswak and also to compare the effectiveness of miswak with modern toothbrushes in terms of oral hygiene practice.

The present review article not only discusses the composition, prophylactic and therapeutic properties of miswak, but also describes the basics of toothbrush and dentifrices. Most of the studies on interaction of miswak with periodontopathogens favored the use of miswak as an oral hygiene aid.

The indigenous system of medicine like herbal chewing sticks (miswak) has been popular since ancient times; further long-term clinical trials are needed to evaluate the therapeutic and pharmacological effects of various chemical components of miswak. More and more studies should focus on clinical effectiveness of miswak as compared with the toothbrush on clinical periodontal parameters such as probing depth, gingival bleeding, clinical attachment level, etc. Effect of miswak should be evaluated separately on periodontally healthy and diseased individuals. Efficacy of Miswak should not be compared with toothbrush alone but also with various fluoridated and non-fluoridated dentifrices. The results from these studies would definitely open new vista in the field of dentistry in providing a foundation for various preventive oral health programs for rural and urban society of India. The knowledge of various medicinal plants being used is confined to mostly local healers, it is of utmost importance to record this knowledge for future generations, otherwise it will be lost forever with the death of local healers/ persons with knowledge about indigenous health care systems. The traditional values, faith, and indigenous knowledge related to indigenous health care systems of the present society are facing serious challenges due to migration of youths to cities and these urban migrants tend to determine their own cultural beliefs and practices. Thus, the recording of indigenous health care system becomes increasingly important for society. On the basis of a literature survey, it has been found that there are various traditional uses of miswak, which has to be scientifically proved.

It is concluded that miswak (*S. persica*) reduces the microbial count in different groups and improves the oral health. The extract possesses antibacterial and anti-plaque property and it can be used effectively as a natural tool for teeth cleansing and as a natural analgesic for the disturbing toothache. The drug is also reported to possess anti-inflammatory, anticonvulsant, sedative, antiulcer, hypolipidemic, and hypoglycemic activities. The present review showed that it is useful in a number of diseases. Therefore it is imperative that more clinical and pharmacological studies should be conducted to investigate unexploited potential of this plant. The research workers have isolated many phyto-constituents from the plant. Nevertheless further investigations are required to isolate and purify novel pharmacologically active and industrially important compounds.