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The First English farm journal from the house of Kerala Karshakan

Puddling An interesting behaviour in butterflies!!

INSIDE KERALA KARSHAKAN
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PIGMENTS FROM VEGETABLES ROLE IN HUMAN HEALTH

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INTRODUCTION:

Pigments are bioactive compounds which are produced within the plants. They are responsible for attractive natural colours of plants and their products. Pigments participate in various metabolic and physiological processes of plants. They play important role in chemo-prevention and reduction of various degenerative diseases. Plant pigments play an important role in human health owing to their capacity of biological antioxidants, conferring to cells and tissue protection against free radicals and oxygen attack.

Vegetables are rich source of natural pigments that belongs to three groups viz. porphyrins, flavonoids and carotenoids. Table 1 show the key pigments and their classification and representative colour.

PORPHYRIN PIGMENT

These groups of pigments contain four porphyrin rings, connected with Mg ion in the centre. Glysine and succinyl co-enzyme are the precursor of chlorophyll biosynthesis. Chlorophyll pigments provide key site for photosynthesis. It acts as potential antioxidants which activates the brain, controls the blood sugar and reduces the blood pressure. It acts as chemo-preventive compounds which reduces the clastogenic effects. Research suggests that it may be important in protecting against several forms of cancer

Table1. Key pigments present in

Sr. no.	Pigment type	Compound class		Compound type	Colors
1.	Porphyrins	Chlorophyll		Chlorophyll a and b	Green
2.	Flavonoids	Anthocyanin		Pelargonidin, Cyanidin, Delphinidin, Peonidin	Red, blue, violet
		Anthoxanthins	Flavonols	Kaempferol, Quercetin, Fisetin, Kaempferide, Morin, Myricetin, Myricitrin, Rutin	Yellow
			Flavones	Apigenin, Biacalein, Chrysin, Diosmetin, Flavone, Luteolin	Yellow
		Isoflavonones	Diadzin,	Genistein, Enterodiol, Coumestrol, Biochanin	Colour less co-pigment
			Flavonone	Eriodictyol, Hesperidin, Naringin, Naringenin Colour less	Colour less co-pigment
			Flavans	Biflavan, Catechin, Epicatechin	co-pigment
3.	Carotenoids	Carotenes		Lycopene, α-carotene, β-carotene, γ-carotene,	Yellow orange, red
		Xanthophyll		Lutein, Cryptoxanthin, Zeaxanthin, Neoxanthin, Rhodoxanthin, Violaxanthin, Canthaxanthin, Astaxanthin	

as the chlorophyll binds to the mutant DNA and prevents it from proliferating (Fahey et al. 2005). The addition of chlorophyll to a heme diet prevented the formation of a cytotoxic heme metabolite. Balderet al., (2006) speculated that chlorophyll traps heme in hydrophobic heme-chlorophyll complexes in the gut lumen and as a result blocks the pre-oxidant activity of heme.

FLAVONOID PIGMENT

They are polyphenolic, water soluble and glycoconjugate compounds comprising of 15 carbons, with 2 aromatic rings connected by a 3-carbon bridge. According to the modifications of the central C-ring, they can be divided into different structural classes including flavonols, flavones, flavan-3-ols, flavanones, isoflavones, and anthocyanidins. They are located in the vacuoles. They are classified in two groups i.e., anthocyanin and anthoxanthin.

Anthocyanin is odourless and flavourless and water-soluble vacuolar pigments that may appear red, purple, or blue according to pH. While, anthoxanthin are white or colorless to a creamy-yellow. The phenylalanine is the precursor of anthocyanins and anthoxanthin. They protect chloroplasts from photo-degradation by absorbing high-energy quanta and scavenging free radicals and reactive oxygen species (Gould, 2004). They are able to stimulate insulin secretion from pancreatic beta-cells. Anthoxanthin are very susceptible to colour changes with minerals and metal ions as well as they are important in nutrition and sometimes used as food additives.

Flavonoids involved in cell signaling through MAPK Kinase pathway and several genes are expressed which stimulate the anti-inflammatory, cell viability and cell communication activities that prevents cancer, cardiovascular and other neurogenerative diseases (David et al., 2010). The various chemical structures in the flavonoid subclasses have been suggested to have different biological impacts on human health. Lin etal., (2007) studied relative risk of nonfatal myocardial infarction and fatal coronary heart disease according to quintiles of intake of flavonols. They found that Kaempferol gives significant results in case

Table 2. Vegetable sources of different pigments

Constituent	Compound	Sources	Established effects on human wellness
Flavones	Luteolin,	Celeriac, celery, peppers, spinach, parsley apigenin	Cancer, allergies, heart disease
Flavonols	Quercetin, kaempferol, rutin	Onions, snap beans, broccoli, kale, myricetin, peppers, lettucer	Heart disease, cance initiation, capillary protectent
Lycopene α - carotene		Tomato Sweet potatoes, green beans, lima beans, broccoli, brussels sprouts, cabbage, kale, lettuce, peas, spinach, squash and carrots Cancer, heart disease, male infertility	Cancer, heart disease, male infertility
ß-carotene		Carrots, broccoli, spinach, sweet potato, pumpkin	Cancer
Xanthophylls	Lutein, zeaxanthin, ß-cry ptoxanthin	Spinach, okra, summer squash, turnip greens	Macular degeneration
Sulphur compounds	Glucosinolates, isothiocyanates, indoles, allicin, diallylsulphide	Broccoli, brussels sprouts, mustard green, horse radish, garlic, onions, chives, leeks	Cancer, cholesterol, blood pressure, diabetes

of fatal coronary heart death. Knektet al., (2002) found that relative risk of several chronic diseases such as heart disease, cerebrovascular diseases and cancer lowered due to higher dietary flavonoid intake.

CAROTENOID PIGMENT

They are orange, yellow and red fat-soluble pigments. They are C40 isoprenoids, consisting of 8 isoprene units. The polyene chain in carotenoids contains up to 15 conjugated double bonds, which are responsible for their characteristic absorption spectra and specific photochemical properties. Carotenoids are powerful antioxidants and quench free radicals and provide protection against oxidative damage. They are "sacrificial" antioxidants because they are not regenerated like other antioxidants, and are degraded in the process of neutralizing free radicals or reactive oxygen species.

Carotenoids contribute to the photosynthetic machinery and protect them against photo damage.In the absence of Carotenoids excess light energy could destroy proteins, membranes and other molecules. Carotenoids are nutritionally important for eye health, normal cell regeneration and other health aspects linked to free radicals.

They are basically divided into two groups i.e., carotene and xantophyll. Lycopene and β-carotene are the major carotenes whereas lutein and zeaxanthin are important xanthophylls compounds present abundantly in green vegetables. They all are located in chloroplast as well as in chromoplast. Acetyl coenzyme is the key precursor of the all carotenoids. Lycopene red colored pigment was first discovered in the tomato by Millardet in 1876.The existence of visible coloured in lycopene containing compounds requires at least seven conjugated double bonds. This unique nature of

the lycopene molecule makes it a very potent antioxidant.β-Carotene is a strongly red orange coloured pigment abundant in plants and fruits. They protect cells from lipid per-oxidation and membrane damage. They play important role in prevention of cancer and heart disease and slow the progression of cataracts.

Agarwal and Rao, (2000) suggested two hypotheses for anticarcinogenic and antiatherogenic activities of lycopene i.e., non-oxidative and oxidative mechanisms. Dietary lycopene increased the levels of lycopene in the blood and other tissues which helps during oxidative stress and several chronic diseases due to their antioxidant and oxidative mechanisms. In case of non-oxidative mechanisms, anticarcinogenic effects have been due to regulation of cell communications. Lycopene is hypothesized to suppress carcinogen-induced phosphorylation of regulatory proteins and stops the cell division at the G_0-G_1 cell cycle phase.

The tomato products and lycopene play a role in prevention of prostate cancer. As the uptake of lycopene increased in the diet the relative risk of cancer was lower as compared to other carotenoids. It has been reported that the serum carotenoid concentration was increased in children eating green- yellow vegetables as compared to the light-coloured vegetables. Lightbourn et al., (2008) reported that black fruit has maximum amount of chlorophyll, carotenoid and xanthophylls due to high concentrations of the delphinidin glycoside in combination with chlorophyll and accessory carotenoid pigment. Chandra and Ramalingam, (2011) found significant variation among tomato fractions tested for lycopene content and reported that highest concentration of lycopene was observed in skin followed by pulp and seed. Table 2 show the vegetable sources of natural pigments and their role in human health.

CONCLUSION

Pigments have multiple roles in human health protection and maintenance.Vegetable provide variety to diet and make the food attractive and tasty due to color, texture and flavor. Pigments act as enzyme inhibitors/activators, anti-inflammatory agents, antimicrobials etc. Different pigments in a well-balanced diet are keys to prevention and therapy for a range of chronic human diseases. Consumption of colourful vegetables rich in pigments, may offer protection against the oxidative damage caused by reactive oxygen species.

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Puddling An interesting behaviour in butterflies!!

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Adult Lepidoptera (butterflies and moths) of many species frequently visit moist ground, perspiration, tears, excrements, or animal carcasses to suck water and dissolved nutrients, a behavior conventionally termed as 'mud-puddling' (Adler and Pearson, 1982). Although this behavior is known from temperate-zone as well as tropical habitats, it is far more common in tropical regions. Large numbers of individuals may congregate at puddles, often neatly arrayed in groups of conspecifics or of butterflies of similar external appearance (Larsen, 1991). Mud-puddling is thought to serve as a means of acquiring essential adult resources, particularly sodium.

In most lepidopterans, the males pass complex spermatophores to their mates which are used to transfer various types of nuptial gifts besides sperms. These gifts may consist of minerals such as sodium or calcium phosphate, toxic secondary plant metabolites or contribute nutrients such as amino acids.

Due to the low sodium content of land plants, many terrestrial herbivores including humans are expected to crave for sodium. In part, this behaviour

Typical mud-puddling pierid butterflies

Papilionids puddling on dung

Red eye skipper feeding on bird-dropping

Julia butterflies drinking turtle tears

in Lepidoptera appears to have evolved due to a shortage of sodium in the diets of many adults. Insects with herbaceous diets, such as caterpillars, are often sodium-deficient due to the low levels of sodium ions produced in photosynthetic pathways of terrestrial plants (Otis et al., 2006). Among the Lepidoptera with their herbivorous caterpillar stages, mineral reserves assembled during the larval phase may often be limiting, and there should be strong selection for strategies to replenish mineral stocks. Toxic plant metabolites which serve as pheromone precursors and nuptial gifts by male butterflies are collected through a special, sexually selected behavioural repertoire. Mud puddling might be seen as the analogous case with regard to minerals. This idea is supported by the fact that most individuals engaged in puddling behavior are males.

Puddling behavior has probably evolved from the drinking of water, and in dry habitats the need for water may be a prime reason for visiting puddles. In the Californian checkerspot butterfly Euphydryas editha bayensis, puddling occurred only in years of extreme drought. Sodium gathered by an adult male butterfly while

Great Nawab feeding on animal excreta

Buck-eye butterfly puddling on carcass

mud-puddling is transferred to his mate in the spermatophores during copulation, which can result in an increase in egg production and sometimes in offspring fitness. Therefore, mud-puddling not only benefits the male nutritionally, but also the female and in some cases their offspring and sodium therefore constitutes a nuptial gift from the male to the female. The importance of sodium to Lepidoptera is suggested by the widespread occurrence of receptors for sodium ions on the tarsi of adults of many species.

What is Puddling?

Puddle is a small body of standing water (rainwater) or other liquid. Puddling is the term given to the aggregation of some insects on wet soil or dung to obtain moisture and nutrients. It is most commonly seen in butterflies with large numbers of individual insects gathering at the edge of puddles, on wet soil, on dung or on carrion. The insects use their proboscis to obtain moisture and also other nutrients and salts. Although puddling is most commonly observed in butterflies other insects, such as leafhoppers and locusts, also exhibit puddling behaviour.

Butterflies, particularly the males, find dissolved salt very attractive. Therefore, on damp sand or mud, one can often see large congregations comprising of a few hundred individuals jostling for space or at times, there may be just a few individuals. This kind of congregation is referred to as mud-puddling. Particularly, good places to see butterflies indulging in this activity would be at the edge of streams or ponds. Many butterflies can be seen visiting oozing tree sap, rotting fruit, dead animals, animal / bird excreta, etc. These could also act as alternate sources of energy for butterflies. In many species puddling behaviour is restricted to males, and the presence of an assembly of butterflies on the ground acts as a stimulus to join the presumptive mud-puddling flock. Many butterflies spend a long time mud-puddling imbibing dissolved salts.

Puddling sites:

Lepidoptera are diverse in their strategies to gather liquid nutrients. Typically, mud-puddling behavior takes place on wet soil. But even sweat on human skin may be attractive to butterflies such as species of Halpe. More unusual sources include blood and tears. Again, similar behaviour is not limited to the Lepidoptera, and for example, the various species of bees commonly called sweat bees are attracted to various kinds of sweat and tears, including that of humans, and other bee species have been recorded as doing so to various degrees. The key is the chemical make-up of the site: salts, minerals and amino acids that play various roles in their physiology and ecology. The choice of resources at puddling sites depends upon mating system of a given species, competitive abilities, nutrient status of the individuals and environmental conditions.

Why Puddling?

The mud puddling of

butterflies is an important natural phenomenon for providing a source of both nitrogenous resources and sodium (Hall & Willmott, 2000), which are not available in nectar and which are essential for sperm production and longevity. The commonest explanation for puddling is that they are taking in water and nutrients. The dissolved salts and minerals may be used to make pheromones (that the male uses to attract females) and sperm. The main stimulant for puddling is sodium. The diet of adults (primarily nectar and fruits) lack sodium/salt, and the host plants that they feed on in their younger larval stages do not provide enough sodium either. Sodium is vital for many physiological functions, including digestion, excretion, reproduction and flight. The males have to sustain high activity levels to be able to fly around and locate receptive females, so they have a need for higher energy and metabolism levels. Indeed, the males of many species are known to be more active and faster in flight than females. Flower nectar is a high-sugar liquid that provides limited nutrition to adult lepidopterans. They need to reproduce and sugar water alone doesn't result in viable offsprings. So butterflies flutter towards puddling sites. Most of the puddlers are males, who ingest the salts, minerals and amino acids that the liquefied source provides. These nutrients are then stored in the sperm. When the time comes to mate, the male passes these goodies along to the female as a nuptial gift in his spermatophore. The female is now in possession of the "extra boost", which she then passes along to her eggs. Eggs that receive this extra nutrient gift have a greater chance of success than those that do not.

Puddling- How long?

A butterfly can puddle from anything between a few seconds to an hour or more, depending on a variety of factors. During the puddling process, butterflies suck the nutrient rich fluids through their proboscis, and "filter" it within their systems to extract the needed chemicals.

Where does the excess fluid go?

Obviously, fluid ejection results from a need to pass great quantities of soil moisture through the gut in order to extract sufficient useful, but dilute, chemicals. If a particular puddling butterfly is closely watched, one can often see sudden, regular ejections, even squirts, of fluid from the end of the abdomen. These regular ejections of fluid can sometimes be powerful enough to reach several body lengths away from the butterfly! While puddling, many butterflies and moths pump fluid through the digestive tract and release fluid from their anus. During puddling, fluid up to 600 times their body mass is pumped through the digestive tract of males (Scott et al., 2003), resulting in the deposition of adhered pollen grains and males have a much longer ileum (anterior hindgut) than non-puddling females. In these moths, this is released in forced anal jets at 3 second intervals.

Conclusion:

Although butterflies are often revered for their beautiful appearance, they might not be as enchanting as the common human concept. They regularly congregate around mud, dung and even decaying corpses. Many species of butterflies are often encountered with their proboscis unfurled and probing into the ground to take in water and nutrients. At the muddy or sandy puddle often tainted with animal urine or excreta, the butterfly sips water rich in mineral salts and other essential nutrients (mostly sodium chloride and nitrogen-rich solutions) that have leached from the surrounding soil and rocks. In most Lepidopterans, the males pass complex spermatophores to their mates comprising various types of nuptial gifts consisting of minerals such as sodium or calcium phosphate.

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Garlic Chive

An underutilized leafy vegetable

Domestication

Garlic chives, also known as Oriental garlic, Asian chives, Chinese chives, and Chinese leek, is a plant species native to the Chinese province of Shanxi that has been cultivated and naturalised throughout Asia and the world.

Morphological Description

Garlic chives (Allium tuberosum Rottler ex Sprengel) is a perennial herbaceous plant with 2-5 leaves, 20-50 cm long, bears flowering scape of 25 - 60 cm tall that grows from an underground short rhizome. The plant produces a clump of small bulbs or bulbils along the rhizome, which grows into a medium-sized clump over time. In warmer climates, the plant is evergreen. The plant is often cultivated for its edible

Botanical classification

Kingdom	:	Plantae
Order	:	Asparagales
Family	:	Alliaceae
Subfamily	:	Allioideae
Genus	:	Allium
Species	:	Allium tuberosum
Common names	:	Garlic chives, Oriental garlic, Chinese leek, Indian leek, Nira, Green nira grass, Mario Nakuppi, imu, Doona, Jimu, Dunduko sag

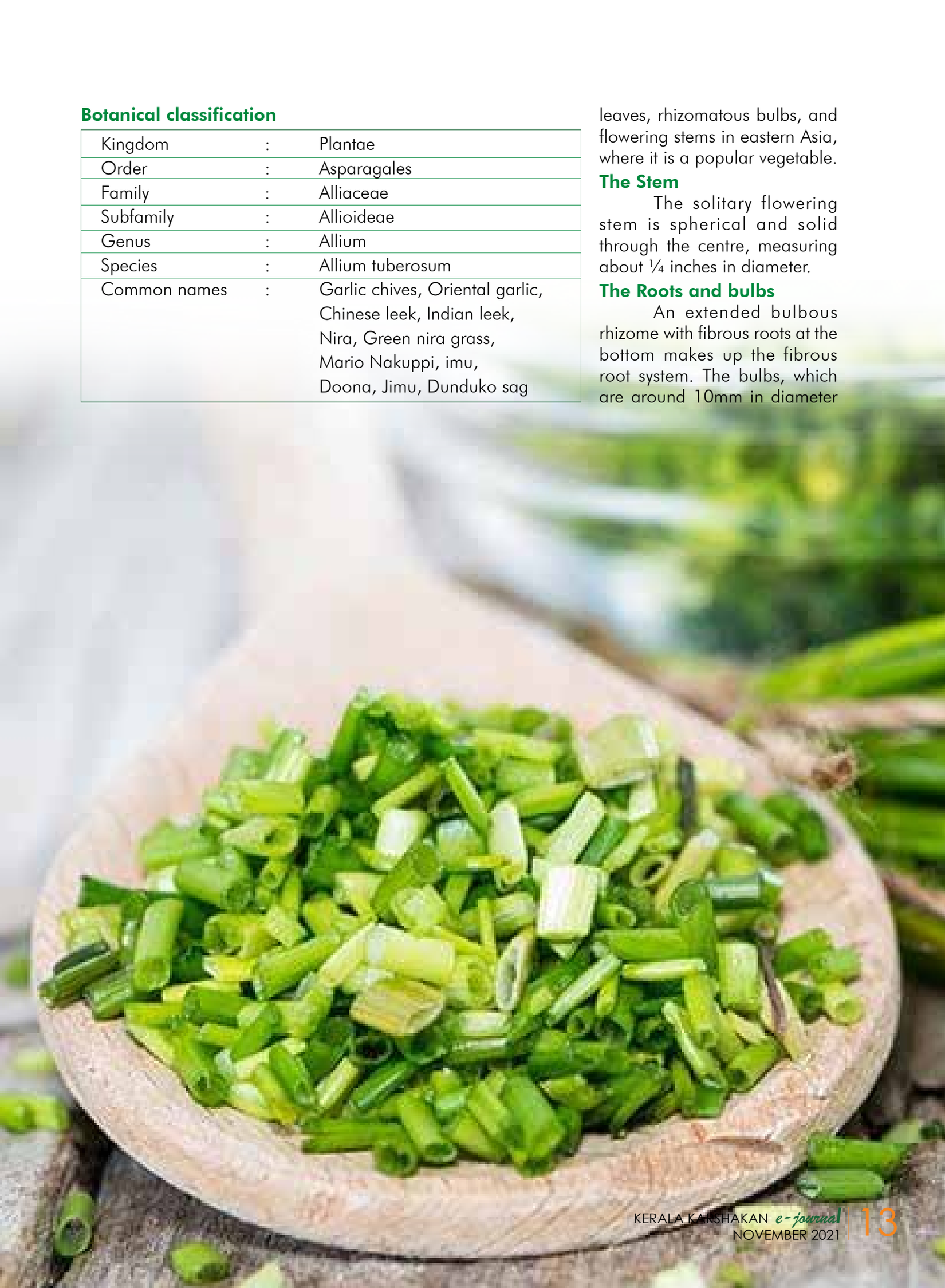
leaves, rhizomatous bulbs, and flowering stems in eastern Asia, where it is a popular vegetable.

The Stem

The solitary flowering stem is spherical and solid through the centre, measuring about ¼ inches in diameter.

The Roots and bulbs

An extended bulbous rhizome with fibrous roots at the bottom makes up the fibrous root system. The bulbs, which are around 10mm in diameter



and grown in clusters on a short rhizome, are quite small.

The Leaves

The leaves are flat and linear, growing 12 inches long and ¼ inch wide, smooth and glossy in texture, have a subtle onion odour when crushed, and are quite floppy.

Cultivation

Garlic chives thrive in both temperate and tropical environments. Bulb creation is aided by high temperatures, while for flowering and seed production cool dry climate is ideal. Flower and seed development can thus occur at higher elevations in the tropics, yet plants rarely generate seeds in the tropics. Short days cause dormancy outside the tropics, while long days induce flowering. Early leaf production is aided by cool season, plants can withstand frost conditions. It is a simple to grow plant that prefers to be in the sun but will accept slight shade. It may grow in a variety of soils, including clay, but prefers a rich, moist, but well-drained environment. Established plants tolerate dry soils and can withstand mild dryness. Throughout the growing season, moist well drained soils are essential, but excessive soil water and high humidity lead to crop loss by stem rotting and disease outbreak. The plant has evaded cultivation for shoot and leaves. Leaves can be harvested 70 to 120 days after sowing, and the same plant can produce leaves up to 5 to 10 years or even more years as a perennial herb.

Edible Uses

Raw or cooked leaves have a mellow flavour that tastes like a cross between garlic and chives, and they are great in salads. Cooking for an extended period of time destroys the flavour. From early spring to late autumn, the leaves are available. They are rich in protein, fat, carbohydrate and ash content. Vitamins A, B1, and C are also present in modest levels. Raw or cooked flowers and flower buds are used in Autumn salad bowl with a great flavouring and a lovely garnished Bulb can be eaten raw or cooked.

Medicinal uses

Antibacterial, cardiac, depurative, digestive, stimulant, stomachic, and tonic properties are all present in the whole plant. It is an anti-emetic that also helps with renal function. Internally, it is used to treat urine incontinence, kidney and bladder weakness, and other conditions. The seed is stomachic and carminative. They are utilised in the treatment of spermatorrhoea in India. Bite, cut, and wounds are treated using the leaves and bulbs.

Other Uses

The juice of the plant is used as a moth repellent.

Propagation

Seeds are sown in a nursery seedbed or in containers. The seed has a limited vitality and should not be utilised if it is older than a year.

When the seedlings are large enough to handle, prick them out into individual pots and put them out when they are grown enough.

Early spring division

The plants are simple to divide and can be done at nearly any time of year, the divisions can be planted directly into their permanent locations. This plant is propagated through seeds and vegetative offsets.

SUCCULENTS

Wonder elements of gardening

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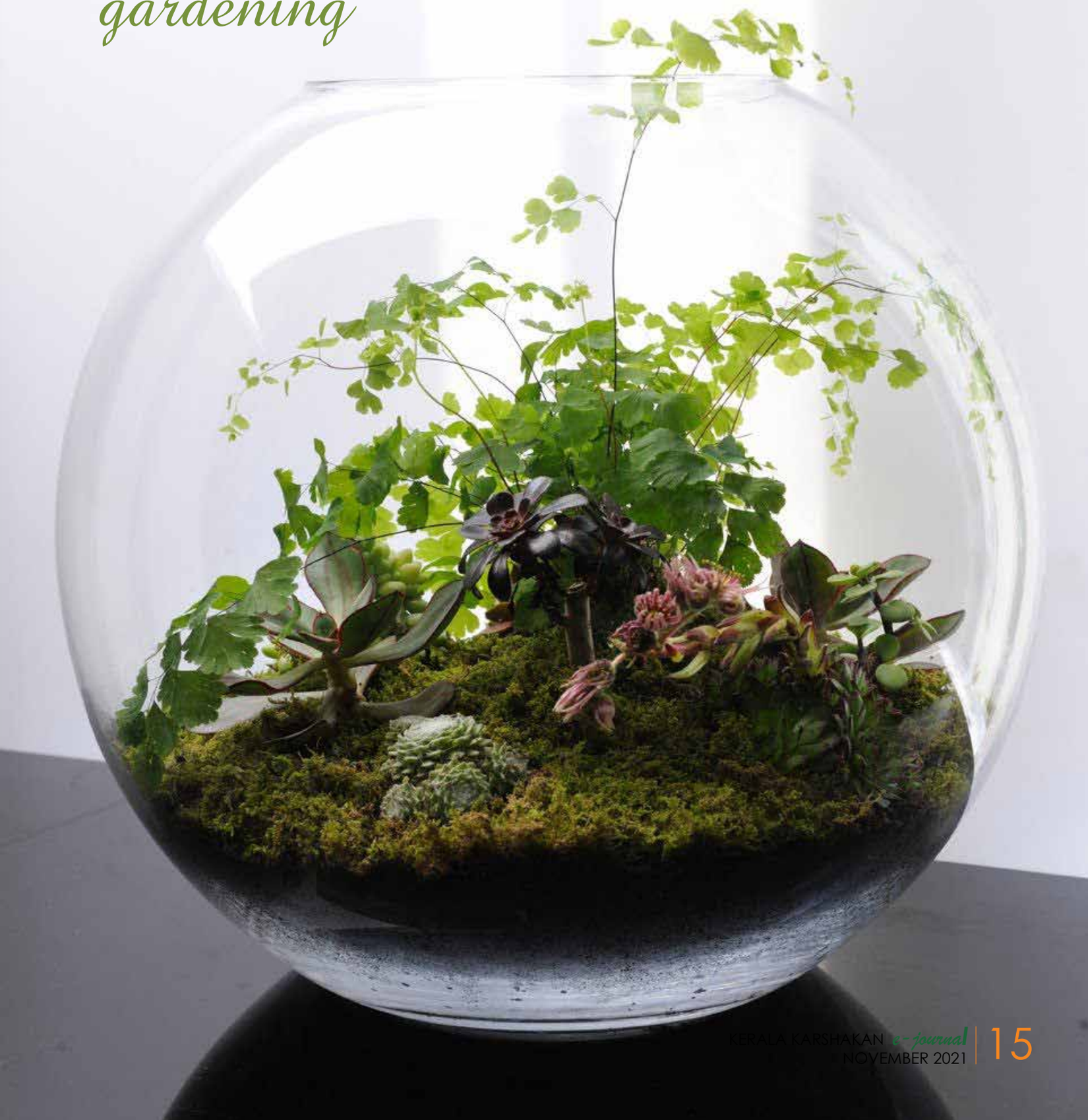


Succulents are the latest trend in the gardening world. Succulents are the most fascinating and diverse group among the ornamental plants and such is their appeal. Succulent plants have got a global distribution ranging from tiny annual plants to huge trees. The word succulent comes from the Latin word "succus" meaning juice or sap. The unique characteristic of succulent plants is the ability to store water in one or more organs of the plant, giving rise to stem succulents, leaf succulents and root succulents the so called caudiciform plants. A succulent (or succophyte) is a plant possessing atleast one succulent tissue. A succulent tissue is a living tissue that besides possible other tasks, serves and guarantees an atleast temporary storage of utilisable water which makes the plant temporarily independent from external water supply when soil water conditions have deteriorated such that the root is no longer able to provide the necessary water from the soil (von Willert et al., 1992). Water content may even be upto 95 percent of the biomass.

Succulents have both foliage value as well as ornamental value. Many plant families have multiple succulents found within them (nearly 50 plant families). Most species in families like Aizoaceae, Cactaceae and Crassulaceae are succulents. Cactaceae is the largest and the best known succulent family. Cactaceae has all its members in the succulent group. Hence all cacti are succulents but all succulents are not cacti. Succulents attract plant lovers with their different growth forms and attractive flowers. Many of these succulents are also of great ecological and economic significance especially in the arid and semi arid parts of the world.

Succulents are often grown as ornamental plants because of their striking and unusual appearance. The habitats of these water preserving plants are often in areas with high temperatures and low rainfall. Succulents have the ability to thrive on limited water sources, such as mist and dew, which makes them equipped to survive in an ecosystem which contains scarce water sources. Many of us know these succulent plants right from the snake plant (Sansevieria), or flowering Kalanchoe or a jade plant or an everliving Christmas cactus (Schlumbergera). Succulents are well noted for their unusual foliage, like haworthias, echeverias and jade plant. Not only foliage, but beautiful flowers are also make them popular like Kalanchoe, christmas cactus etc.

The genus Aloe is a succulent group and comprises more than 500 species ranging from small succulent plants to tall trees. The leaves in most species have sharp teeth along the margins and in some species there are prickles and/or pale spots on one or both surfaces. Aloe species and hybrids are popular as ornamental houseplants and used in drought-tolerant landscaping. Aloe vera is the best known species in this genus. Crassula is a genus of succulent plants containing around 200 species. The popular jade plant is a memeber of this family. Crassulas can be propagated by stem or leaf cuttings. *Crassula ovata* (jade plant), *C. cotyleddonis, C. capitella* etc are some members of this genus. Haworthia belongs to Asphodelaceae family and generally resemble miniature aloes in foliage. Haworthia consists mostly of dwarf rosulate succulents, often proliferating from the base and forming dense clusters with smooth to tuberculate (rarely pubescent) leaves. *H. angustifolia, H. bayeri, H. arachnoidea, H. fasciata, H. cooperi, H. fasciata* etc are the members of this group. These plants are well noted for the unusual texture and size. About 10,000 plant species are generally recognised as succulents, of these an estimated 2000 species are threatened with global extinction in the wild and many more are regionally and nationally threatened (Carter, 1997). So these plants require greater attention in this scenario.

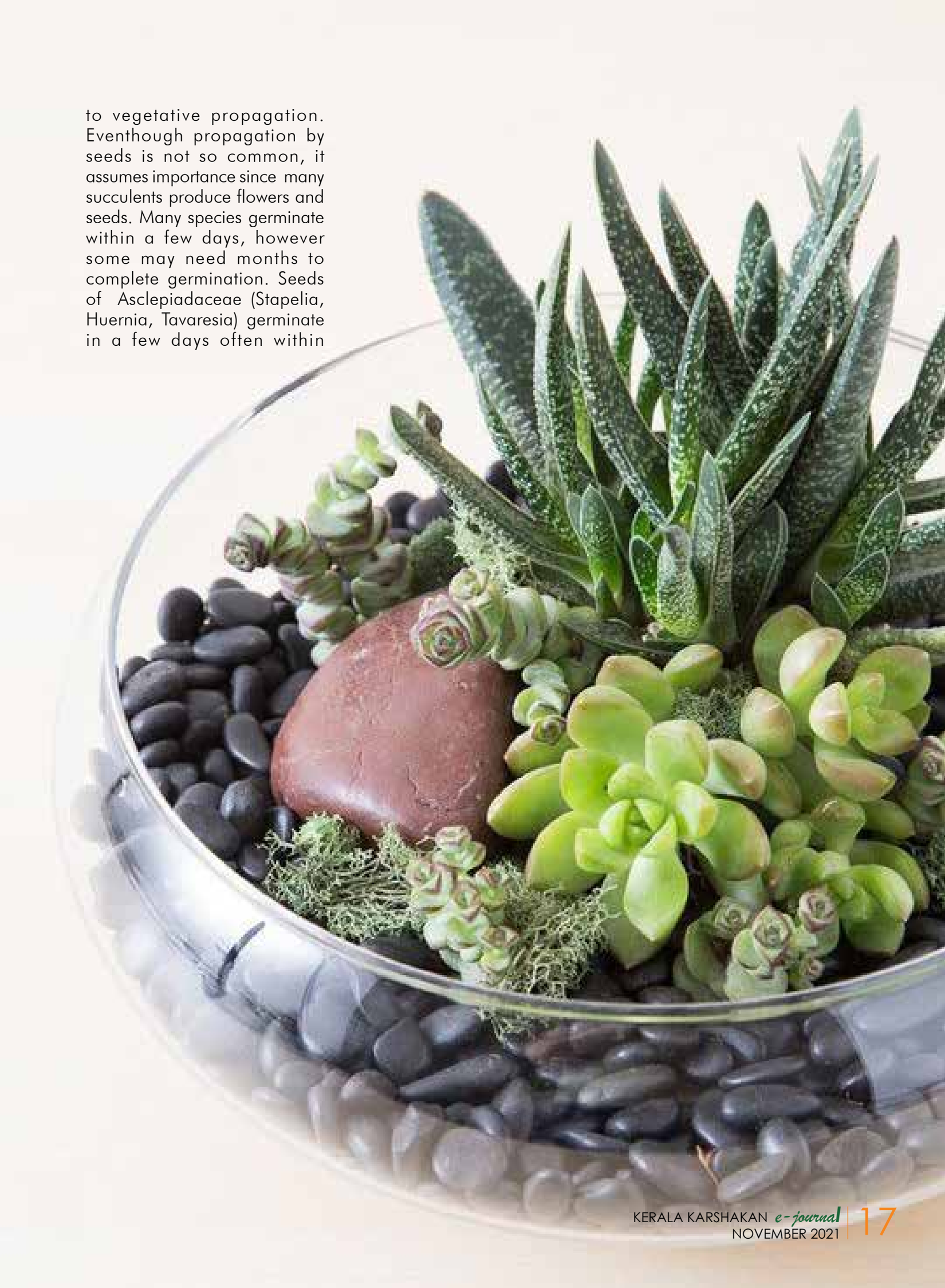
Growing environment

Succulents are favoured as houseplants for their various incredible and attractive growth forms and size. Many of them are tiny plants which can be adapted well to the confined interiors of flats and buildings. Succulents require plenty of air. Some prefer plenty of sunshine, while some prefer shade or half shade. Many of them cannot withstand direct scorching sun. Most of the succulents grow in xeric habitat. Hence a xeric habitat is necessary for the growth of these plants. Therefore, the possible modification of the growing environment is by means of providing partial shade, protection from rain etc. Some plants like Agave, Adenium, Gymnocalycium, Opuntia etc which are well adapted to the humid tropics can be grown outdoor.

Propagation

Succulent plants can be propagated easily by different methods right from seeds

to vegetative propagation. Eventhough propagation by seeds is not so common, it assumes importance since many succulents produce flowers and seeds. Many species germinate within a few days, however some may need months to complete germination. Seeds of Asclepiadaceae (Stapelia, Huernia, Tavaresia) germinate in a few days often within



a day, whereas seeds of Mesembryanthemum germinate between 3 to 60 days depending upon the species. Most of the cacti seeds germinate within 8 to 10 days, some may require a month. The seedling may be kept under care depending upon the growth rate and later transplated when the seedlings are hardy.

The most common methods of vegetative propagation include cutting, offsets, suckers, adventitious buds, division etc. Stem cuttings can be practised by separating matured twigs by horizontal cut and dried for suberisation of the cut ends. Propagation through leaf cutting is another method which is a very simple and easy propagation method in many succulents like Kalanchoe, sedum, Gasteria etc. Mature healthy leaves are plucked by twisting or cutting and kept in potting media under shade. This method is not feasible in most of the cacti and other succulents where leaves are either absent or modified. Roots and buds will develop within two to four weeks. Many succulents in the genera Sedum, Haworthia, Kalanchoe etc can be propagated from the dormant bud at the leaf edges, axils and notches. The leaf should be so separated that the buds are not damaged. This method is slow but a large number of plants can be obtained from a single piece. Many succulents produce offsets which can be used for propagation after attaining reasonable size. In some cacti like Echinopsis and succulents like Agave and Haworthia the offsets develop roots still attached to the mother plants which can be separated from the main plant with a sharp knife without damaging the mother plant. Shallow pots encourage the production of more offsets. Grafting is also practised in many cacti.

Cultural practices

Succulent plants can be grown in various types of containers ensuring proper aeration and drainage. Shape and size of the container should confirm with the size and shape of the plant and the nature and spread of the root system. Drainage holes must be provided irrespective of the container type. Many succulents have fibrous roots and do not require deep pots and half pots or even pans are suitable for planting. Succulents with tap roots or tubular roots require standard pots. For plants with long tap roots or carrot like roots deep pots are used and shallow pots or pans may be used for shallow rooted plants like Mammillaria, Echinocereus, Haworthias etc. Size of the pots should be just large enough to accommodate the plants, too big pot with enough media keep extra water which may damage the plants. The plants may become pot bound quickly and growth becomes restricted if small pots are used.

Succulents can be grown in various potting media. The succulents in general prefer well drained porous media with adequate organic matter. Before planting in pots, the roots should be examined for rot or any infection and treated properly. Repotting is an operation for healthy root development when the roots get pot bound. Repotting is necessary every 2-3 years for healthy plant growth.

Watering of succulent plants needs proper attention. Most of them are desert plants with xerophytic nature. It is always better to check the moisture content of the media before watering and water the media, not the leaves. Many plants require watering once in a week.

Soggy leaves indicate overwatering in succulents. Application of water twice a week during summer, once a week during rainy season and once a fortnight during winter can be followed. Watering can be preferably done during early morning. Never water a plant in full sunshine as there are chances of cell bursting and ultimate scorching. Most of the succulents are slow growing. Groom the plant often by removing the dead leaves.

There is wide scope of succulents as ornamental features. They can be effectively used in landscaping and both indoor and outdoor decorations. They are perfect candidates for rock gardening, bowl gardening and miniature gardening. In spite of the extraordinary and unusual environment that influences the growth and development, succulents make some of the best indoor plants and outdoor plants and are truly wonderful.

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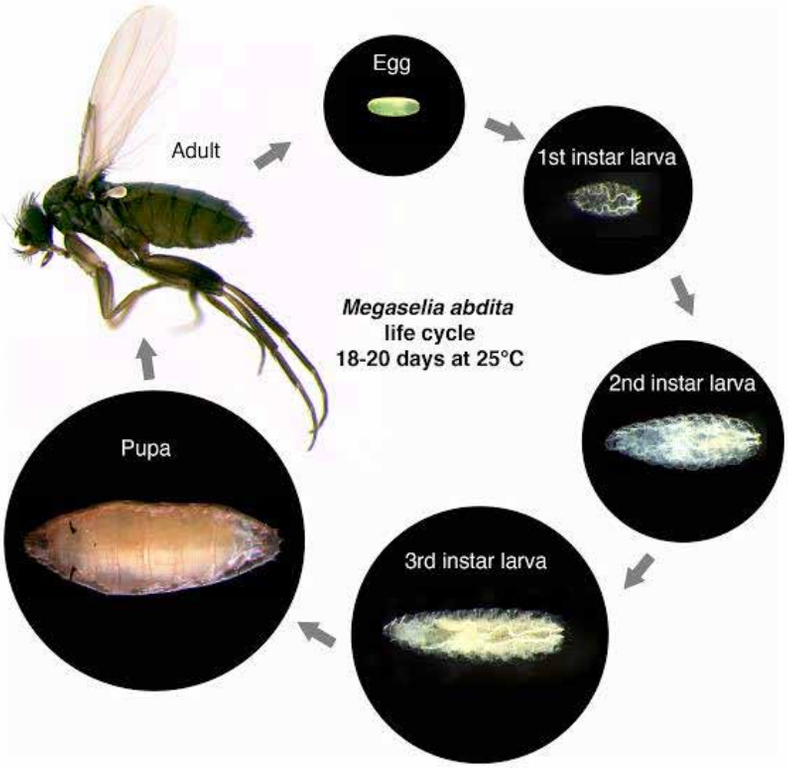
Scuttle Fly

A New Threat to Silkworm Seed Production Centre

Megaselia scalaris (Scuttle fly) is a Dipteran fly in the family Phoridae. This fly resembles the fruit fly, Drosophila, but slightly larger than fruit fly and named as scuttle fly because of the short, rapid bursts of running motion characteristic feature of adults. The species is alternatively referred to as the 'humpbacked fly' because of its hump-backed appearance or the 'coffin fly' because of its ability to dig deep into the ground to reach buried carrion and penetrate closed containers such as coffins or also known as "phorid fly" (Figure 1). The fly is only 2 mm long, brown and yellowish in colour with some dark markings on the abdomen. It is a holometabolus insect which have four distinct stages of growth: egg, larva, pupa and adult.

M. scalaris is an omnivorous insect and feeds on a wide variety of food, ranging from dead or alive animals, moribund insects, fruits, fungi and laboratory foods (Disney, 2008). They are reported as predators or parasites of earthworms, snails, spiders, honey bee, termite, ants, centipedes, millipedes, insect eggs, larvae, and pupae and they are able to maintain themselves and multiply in colonies which need a humid and warm environment. They are often found in habitats ranging from urban buildings to tropical rainforests, and especially thrive in unsanitary conditions such as trash containers, public restrooms, sewage pipes, and litter boxes being attracted by the strong smell of decaying matter. Scuttle fly has been playing a beneficial role in forensic entomology, but recently during the year 2018, Debnath and Roy reported it as a pest for commercial breeding of insects mainly honey bees by the mechanism of parasitoidism where the female fly lays eggs on their abdomens at inter-segmental membranes, which hatch and feed on the bee and the bee die. The fly larvae then emerge from the neck of the bee, pupates and emerges out as adult.

In recent days, a similar case of parasitoidism by scuttle flies were reported for the first time in silkworm pupae as well as moths. As there was continuous rain in Southern Karnataka, the sudden outburst of scuttle flies has increased rampantly in some silkworm seed production areas due to prevailing congenial warm and humid climate causing major loss in the silkworm seed production. In silkworm seed production process silkworm pupae of both the sexes were used as a basic material for seed production. The scuttle files were being attracted towards one or two melted silkworm pupae due to the strong smell as well as its protein rich body content (55.6%



on dry wt. basis) similar to its attraction to the stabilimentum of the spider's web by the strong smell of decaying matter (Henaut et al. 2010). It was also revealed by Disney during 1994 that these files require proteinous food source to mature their eggs. The attracted flies lays eggs on the intersegmental region of the abdomen of live silkworm pupae (fig. 2), which later hatches and young larvae feed on the soft tissues of live pupae and eventually pupae dies. Predatory and parasitoid nature of larvae of M. scalaris on insect eggs, larvae, and pupae are also reported in the field. Adults of scuttle flies feed on liquid which oozes out of silkworm pupae after its larvae decays the silkworm pupae and females feeds on the soft tissue of the pupae while it lays the egg. Sugar is the primary food for adults hence some adults feed on the body liquids of living beetle larvae and pupae, others prey on small insects as reported by Disney (1994) in his study. Field reports have also demonstrated the ability of this scuttle fly to feed on a huge range of living arthropods, including members of the following orders: Lepidoptera, Orthoptera, Diptera, Coleoptera, Hymenoptera, Ixodida, and Araneae, some of which are of agro economic ecological and commercial importance.

In addition, it was also noted that after copulation, when the gravid female moths of silkworm were kept for egg laying in separate dark room at 25°C temperature and relative humidity of 75%, the female scuttle flies were observed to lay eggs on the abdomen of the living female silkworm moth. Due to continuous emergence, the silkworm pupal population declines and scuttle flies continues its life cycle on the silkmoths by laying eggs. It was also reported by Zwart et al., during 2005 that adults of scuttle fly find only organic material to deposit eggs, where it's larvae could find food, warmth and humidity.

The scuttle fly eggs later hatches and young larvae feed on the moths abdomen (Fig. 3). Because of this, the affected female silk moths fail to lay the eggs fully, while few moths could lay only few eggs resulting in low egg recovery and the infected silkmoths die. Due to heavy rain, as there was no other organic material available outside the building, the adult flies after laying it's egg on silkmoths, the scuttle flies also feed on the newly laid eggs of silkworm.

In order to get rid of Scuttle flies parasitoidism, preventive measures such as constant cleaning of the floor with insect repellent solvents like Decol, the mechanical protection of pupae and gravid moth with nets covering the trays, doors and windows of the grainage rooms as the first choice, since chemical control of Scuttle flies are not advisable during the silkworm seed production process as it is harmful to silkworm. However, after sudden incidence of scuttle flies at our Centre, usage of mosquito bat resulted in killing male Scuttle flies to an extent of 70% and sticky traps of yellow and blue colour helped to kill both male and female Scuttle flies (Fig.5) which resulted in reduction of pest population. Further studies need to be undertaken by the research institutes to identify the suitable biological control measures to help the silkworm seed production centers to control scuttle flies effectively to enhance silkworm egg recovery and save the sericulture industry from the huge loss.

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UNDERSTAND ROOF GARDEN BEFORE YOU REGRET

"Growing your own food is like printing your own money." This was once quoted by the gangsta gardener Ron Finley. Nurturing a garden feeds not only our body but also our soul. And, yes, it cuts the costs of daily expenses too. Having a roof garden is always a fruitful thing. It increases physical activity and emotional wellbeing. Also makes our home and surroundings fresh with abundance of clean air and what more could be




pleasing than to have a quick stroll in the nature to calm our nerves from the current stressed situations we face.

Furthermore, the demand for vegetables is increasing due to the tremendous growth in population. The present production of vegetables is not sufficient to meet the daily per capita requirement of 300g. Also vegetables are an important part of our diet which keeps us healthy and helps to fight diseases. So having an organic roof garden seems to be the best choice to produce fresh vegetables which can lead to a healthy society.

Mrs. Reji Jayachandran, a homemaker from Kottayam, has turned her lockdown period to a perfect time starting a roof garden. She has tended to her roof garden for more than a year now. She started with chillies and brinjal and now her roof has almost 15 varieties of vegetables. Other than vegetables, she grows different varieties of flowers too. "The lockdown have presented me with a good opportunity to connect with nature and plants. Every morning I'm excited to see which all plants have bloomed and what all are ready to be reaped. I also watch bees as they gather nectar from my flowers. It is so peaceful to see and enjoy such simple yet beautiful things around us." Mrs. Jayachandran

says.

Her mornings normally begin with watering her plants and plucking the fresh vegetables. She makes a second round of scroll in the evening to check upon her plants. She sprays homemade fertilizers. She uses no chemicals or harmful pesticides on her plants. "The ways of preparing containers too are very easy. You just have to have a little patience", she says. She mixes the soil with agricultural lime and keeps it for 15 days to bring about the accurate pH. Then she fills half of the grow bag with dry leaves and half with potting mixture which contains soil, coirpith, cowdung powder, compost, neemcake and bone meal.

Mrs. Jayachandran is particular about making her organic fertilizers at home. She efficiently uses all the kitchen and food waste for her roof garden. "Fermented rice water is the key substance in all fertilizers. Fermented rice water with garlic is used as an effective fertilizer. Jaggery , groundnut cake , neem cake , cowdung , bone meal , along with fermented rice water is mixed and kept for 5 days. After 5 days, it is diluted with water and sprayed. Also cow's urine with wild pepper chillies are used against pests", Mrs. Jayachandran says. With all these methods, Mrs. Jayachandran's roof garden has given her a wide range of vegetables. "Our garden provides us with 90% of the vegetables for the whole family. We rarely step out to purchase vegetables. In this depressing situation, when we can't go out for any entertainment or socializing, plants are my best companion which keeps me happy, healthy and busy. All thanks to the roof garden up there!" she added.

Mrs. Jayachandran's roof garden is an example of sustainable urban agriculture. For someone who lives in an apartment or a house with no yard and wishes to grow a garden, then roof garden is a great choice. Or else they can join a community garden. Gardens hold plentiful advantages and help you to become self-sufficient in the matter of food. It is a big step towards living a sustainable life. Producing our own food can reduce our carbon footprint considerably. It also helps to conserve natural resources, save money, and to lead a healthier lifestyle.

The vegetables we usually buy from the markets are contaminated with tonnes of chemicals pesticides and fertilizers which are not good for our body. These vegetables may appear harmless on our plates, but has so many repercussions on our health. So, start from anywhere! It's not only the rooftop but also balcony, windowsill or anywhere you could spare a little space. Start with baby steps and you will be able to sprint someday.

Growing food in the confined urban home will seem impossible until you know how to make use of your little balcony and window-sills. You just have to find a little space on your rooftop, some containers and compost. And don't forget about seeds and saplings.

Composting will help you make good use of your kitchen wastes. And mostly, people assume that composting is a complex task. But a bit more complex task is to stick to your kitchen scraps and food wastes and cooks in a stinky kitchen. Don't put yourself down for any amount of food you grow. Any amount of food you grow is a really positive step forward. So start small and as time goes by, you can add more and more to your plant varieties.

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KARONDA
A source of Nutraceutical

Carissa carandas is a species of flowering shrub in the dogbane family Apocynaceae. It produces berry-sized fruits that are commonly used as a condiment in Indian pickles and spices. It is a hardy, drought-tolerant plant that thrives well in a wide range of soils. Common names in English include Bengal currant, Christ's thorn, Carandas plum and Karonda. It is widely used medicinal plant by tribes throughout India and popular in various indigenous system of medicine like Unani, Ayurveda and Homoeopathy. The fruit is simple, succulent, fleshy, globular, 14–18 mm diameter. The epicarp is thin, whitish pink and of maroon colour when ripe. The unripe fruits have astringent taste owing to rich content of iron and vitamin C which has antiscorbutic property and can be used for the treatment of anaemia.

In the traditional system, it is known to treat different human ailments as an astringent, appetizer, antipyretic in stomach disorders, rheumatism, treat brain disease, anthelmintic, cardiotonic and lowering blood pressure. Fruits of *C. carandas* have been used to treat various human ailments such as oedema, hepatomegaly, splenomegaly, indigestion, cardiac diseases, amenorrhoea and it is useful in treating of brain anorexia disease. It is also useful for the treatment of fever, sour, acrid, appetite loss, antipyretic, piles and act as nervine to calm the nervous disorder and having antiscorbutic properties used to treat anemia. The root part is being used to improve digestion, anthelmintic, antimicrobial, stomach disorder, intestinal worms, scabies, diabetic, ulcer, pruitis and also used to reduce high blood pressure.

Chemical composition of karonda fruit

Components	Values (mg/100g)
Total acids	9 to 11
Total Protein	0.39-0.66
Total crude fat	2.57-4.63
Fibres	0.62-1.81
Carbohydrate	0.51-0.94
Sugar	7.35-11.58
Iron	150
Calcium	115
Phosphorus	66
Energy (kcal/g)	338-342
Ash	0.66-0.78
Moisture	83.17-83.24

Extraction methods

1. The pulverized leaves and fruits of the plant was extracted with different solvents using various extraction methods such as: methanol (70%), ethanol (80%), ethanol (95%), ethanol and water (1:1), cold aqueous and ethyl acetate (80%) in a soxhlet extractor, maceration and shaker.
2. Extracted solvents are then concentrated with rotary evaporator
3. Concentrated extract is then spray dried or freeze dried
4. Dry karonda powder can used for development of nutraceutical

Nutraceutical

Nutraceutical is the term, which combines the word nutrition and pharmaceutical, is a food that contains a medical health benefit beyond that of basic nutrition. A food or part of a food that allegedly provides medicinal or health benefits, including the prevention and treatment of disease. A nutraceutical may be a naturally nutrient-rich or medicinally active food. Nutraceuticals mainly contains

Nutrients: Substances which have established Nutritional functions e.g. Vitamins, Minerals, Amino Acids, Fatty acids, etc.

Herbals/ Phytochemicals: Herbs or Botanical products.

Dietary Supplements: Probiotics, Prebiotics, Antioxidants, Enzymes, etc.

Nutraceutical activities of *Carissa carandas*

1. **Anticonvulsant activity:** the ethanolic extract of karonda root helps to supress the excessive rapid firing of neurons during seizures, also prevent the spread of the seizure within the brain.
2. **Hepatoprotective effect:** The ethanolic extract of karonda root protect liver from poisoning.
3. **Cardiovascular activity**: The ethanolic extract of leaf of the karonda exhibited cardiotonic activity and lowered the blood pressure. The cardiac activity of plant has been recognized as due to the presence of water

soluble glucosides known as odoroside.

4. **Anti-malarial activity**: Methanolic and aqueous extracts of leaf, stem bark and fruit of the karonda acts against malaria which is transmitted by mosquito.
5. **Antimicrobial activity**: The ether and methanolic extracts of leaf and stem showed better antibacterial activities against both gram positive and gram-negative bacteria. It indicates the presence of broad spectrum antibiotic compounds which exhibited higher degree of antibacterial activity against *Staphylococcus aureus and Escherichia coli* which are responsible for cause of gut infection, stomach ache and diarrhoea.
6. **Antiviral activity:** The ethanolic extract of fruits possess effective antiviral activity against polio virus and HIV-1.
7. **Anti-diabetic activity:** The ethanolic extract of fruits possess anti diabetic activity which helps to reduce blood glucose level, this is due to the presence of polyphenol and flavonoid content of the extract.
8. **Adaptogenic activity**: The ethanolic extract of fruits consists of adaptogens, they work to counteract the effects of stress in the body.

9. **Anthelmintic activity**: The ethanolic extract of unripe karonda fruits acts against parasitic worms (helminths) and other internal parasites from the body by either stunning or killing them and without causing significant damage to the host.
10. **Antioxidants and anti-cancer activity:** It was studied that the methanolic extract of karonda leaf showed significant anti-cancer activity against lung cancer and human ovarian carcinoma cells. The isolated pentacyclic triterpenoid carandinol (3β, 21α-dihydroxyisohopane) from the extract of leaf is anti-cancerous.
11. **Anti-hyperlipidemic activity: The ethanol:** aqueous (1:1 ratio) extract of leaf is also reported to have significant anti-hyperlipidemic activity toward cellular damages caused by hyperlipidemia which is caused by consumption of bad cholesterol.

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Petunia

Enchanting member of home gardens

In Kerala, the plant nurseries have been occupied with a beautiful multi colour flower species called petunia during January – March months. These plants are nowadays contribute to the beautification of home gardens in our state. The wild type of petunia 'Petunia integrifolia', which is violet/ purple in colour, is familiar to our gardens and it is also seen in our rural households. This wild petunia is the mother of all garden petunias. But, now hybrid form of several multi colour petunias (red, white, multiple shades) are attracting the heart of flower lovers. It has a long term effect on adding colour to our garden because of its showy trumpet or funnel shaped flowers.

Petunia is a tender annual flowering plant coming under solanaceae, which includes our agricultural crops like potato, brinjal, tomato etc. It has its origin in South America and divided into two or more groups. *Grandiflora petunias* have very large flowers and are best grown in containers or hanging baskets and they are more susceptible to rain damage. Multiflora petunias have smaller, but more abundant flowers and are more tolerant to wet weather. Spreading or wave petunias are other important group which have the ability to fill flower beds with their blooms that sprout all along their stems, which can reach up to 4 feet. Miniature types are also available which is called as tiny petunias or million bells.

Petunia can be propagated by using seeds or by cuttings. It needs a well-drained sandy or clay soils with pH of 6 -7.5. It is a sun loving plant and can tolerate heat up to a certain extent. It will flower profusely during summer months. It cannot withstand water logged conditions and can be died off due to excess irrigation. The water can be applied by checking the moisture status of soil. Extreme care is needed to protect this plant from over irrigation. Moisture and sunlight are the major factors affecting petunia growth. Addition of organic manures will increase the growth of this plant also, just like other ornamental plants. Because of their profuse blooms, petunias are excellent in hanging baskets, either alone or as a trailing plant in a mixed planting. Containers of petunias can be placed in strategic areas of the garden, to add colour where needed.

The most important after care of this plant is pinching. Pinching the plants can increase bloom stems and discourage vegetative growth. Removal of deadheads is also important for petunia which means the clipping off the old blooms in order to increase flowering. This management practice is very important for reviving and profused flowering of these plants. These plants are rarely infected with pests and diseases but can be affected with aphids, caterpillars, leaf miners, bacterial soft rot, leaf spots or viruses.

Petunias are now gaining importance as an ingredient which is adding different shades to our garden. Proper planting and caring of these beautiful plants are needed in order to bloom it profusely.

Indian Linaloe

The Scent of India

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Bursera is an aromatic essential oil plant introduced into India by Mexicans in Bangalore region. It is commonly called as linaloe tree, Indian Lavender, Copal lemon, Elemi gum and Indian Linaloe etc. It belongs to family Burseraceae. Genus name Bursera, is named after the Danish botanist Joachim Burser (1583-1639). There are hundreds of described species in genus Bursera includes flowering shrubs and trees varying in size up to 25 m (82 ft) high. They are native (often for many species endemic) to the central America. It is an aromatic essential oil plant introduced into India by two private enterprising Scotsman in 1912 at Thatgunni estate near Bangalore, Karnataka state. But Karnataka state forest department has started it's cultivation since 1958. Even then also the cultivation is very much restricted to Bangalore region only.

Uses: Both the wood and mature fruit yield on steam distillation a colourless or pale yellow essential oil traded as 'Linaloe Wood Oil' and 'Linaloe Berry Oil'. They have a similar composition with an agreeable balsamic, slightly rose-like aroma used to scent perfumes, lotions, soaps and cosmetics as well as flavour foods such as baked goods, chilled dairy desserts and beverages, both alcoholic and non-alcoholic. The berry oil is said to be superior to the wood oil, with a longer lasting aroma. The oil extracted from seeds in these trees is a major ingredient in making expensive perfumes abroad, especially in Russia. In Mexico the oil is distilled from the wood of wild trees that are at least twenty years old, with the best oil coming from much older trees, whereas in India the oil is distilled only from the husk of mature fruit, leaving the tree unharmed. In India, the mature fruit are hand-picked from the tree or are collected after they have fallen to the ground. They are then shade-dried and de-husked, with production roughly at 250 kilograms of dried husks per hectare. With an average oil content of 10% the yield is

about 25 kilograms of oil on distillation, the equivalent of 22 pounds of oil to the acre. The tree is commonly used as living fence posts in Costa Rica. Essential oil is being used in cosmetic industries, soaps and detergent industries.

History of seed

Bursera tree, botanically known as *'Bursera penicillata'*, native to Mexico in Central America, were said to be introduced to India by two European brothers. These European brothers surveyed entire India and found Bangalore was suitable for cultivating these plants. Initially, the brothers raised these trees in the same area and wanted to establish their monopoly in growing them. Even the local villagers were denied these seeds. Later, the artist couple bought the area and began cultivating them. Realising their importance in cosmetic industries, the forest department began growing these trees in a vast area near Hoskote near to Bangalore.

Now, this tree can be found in many places in gardens but not on commercial scale. The forest department itself began extracting oil from its seeds. Oil can be extracted from the tree bark and the stem. Even by removing the bark on tree surface, scented oil starts oozing out.

Season of Aroma

In case of European lavender or true lavender flowering months will be winter but this tree yield is mostly during July and August, when the nearby areas filled with aroma of lavender disseminated from seeds. Even bark of the stem is also having essential oil that bears aroma. This plant is one of the highest essential oil yielding plant among all aromatic crops. It yields around 7-10% oil on steam distillation of berries.

Soil and climate: It grows well on various type of soils especially in lateritic red soils. It performs best on free-draining loam, sand and gravelly or limestone soils of a slightly acid to alkaline nature, generally with a pH of 6.5 to 8.5 and on sites with full to partial sun exposure. The plant prefers arid tropical climate with temperature variation between 18 ° C and 35 ° C. the plant can survive very less water condition and needs rainfall around 450mm to 650mm annually. The climatic conditions around Bangalore and similar type are very much conducive to grow this species on a large scale.

Propagation: Plants are dioecious and known to regenerate both by artificial and natural means as well as by sexual and asexual methods, cuttings being the commercial method. Seeds possess poor seed germination rate, slow seedling growth and high variability. Hence, terminal stem cuttings or air layering of 15 cm length and pencil thickness are used to prepare nursery plants. A vegetative propagated plant sprout early and also comes to bearing early as compared to seed propagated plants. Even bigger sized branches can also be planted but rooting will be less and not economical. Hence stem cuttings are mostly practiced. The cuttings are planted in 0.5m cube pits dug at 6 × 6m interval. A fertilizer dose of 40-80:20-40g of Ammonium sulphate, Superphosphate and MOP per plant per year could be applied to have vigorous growth.

Pest and diseases: No serious pests and diseases have been reported except for *Pestalotia helerocornis* fungus which causes die-back. Proper canopy management is sufficient to manage the disease.

Harvesting and processing:

Plants raised from cuttings set fruits in first year itself whereas seedlings takes five years to bear fruits. Being a deciduous species tree remains leafless from November to March and new flush starts during April-May with simultaneous flowering. Trees starts bearing 3 to 4 years after planting. On an average, each tree yields 40 kg of seeds. Harvesting is done either by picking of berries or by collecting the fallen berries during August.

The oil is distilled by usual steam distillation of air dried husks which yield 10 to 14% of oil. Fresh berries take five hours for distillation while dried berries take 20-25 hrs. About 25kg of oil can be expected from one-hectare plantation. The seed oil produced in India is known as Mysore Linaloe oil or Indian linalool oil. Trees attain maximum bearing 13 years after planting, when the yield of oil is expected to fetch Rs. 6000/- per hectare.

Linalool 47%, linalyl acetate 40% are chief constituent and other sequiterpenes are major aroma compounds in essential oil of husk. Leaf oil has sweet wafting odour and it contains 65-70% linalyl acetate. Because of stability to alkali the oil is used in manufacture of scents, cosmetics, transparent soaps. Oil is also used as fixative in perfuming lily, cananga, lavender etc.

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Energy deficiency and metabolic disorders in Lactating cows

The stomach of herbivores farm animals have multiple compartments to break down complex carbohydrates like cellulose with the help of a host of microorganisms thriving in their fore-stomach (rumen). The rumen is considered as an ecosystem due to the coexistence of bacteria, archaea, and eukaryotes. Stomachs of ruminants are evolved to survive on roughages which contain fibre. Fibre in roughages is of two types viz. neutral detergent fibre (NDF), acid detergent

fibre (ADF). Plant materials like cellulose, hemicelluloses and pectin constitute NDF. Intake of roughage by ruminants decreases with NDF content in roughage where as digestibility decreases with the elevation in ADF content.

Dairy production systems in developing countries are diverse in nature. At one extreme is the high input systems with superior animals fed on balanced rations, adopting automation in management and on the other extreme is the low input systems with low quality feed and poor management. Interventions to improve milk production in low input systems aims at resolving nutritional deficits in diet so as to improve reproductive efficiency and milk production. The basic principle is to optimize rumen for microbial digestion process. Supplementation of energy rich and easily digestible carbohydrates were known to improve milk production. However the same can adversely affect rumen environment due to the ensuing changes in acidity. Some of the commonly encountered energy related disorders among dairy cattle in Kerala are Acidosis, Laminitis, Ketosis, fatty liver disease and low milk fat syndrome which are briefly discussed below.

Rumen acidosis

It occurs when cattle gain access to and consume large quantity of easily fermentable carbohydrates. Cereals like rice, maize powder, ripe jack fruits etc have the potential to cause rumen acidosis. The pH of rumen will be between 6-7 in cattle maintained on roughages or could be as low as 5.5 in animals fed with high grain rations. Upon feeding large quantity of easily fermentable items, bacterial digestion in rumen releases volatile fatty acids (VFA's, viz. acetic acid, propionic acid, butyric acid), lowering the pH. Bacteria which produce lactic acid thrive under such condition and concentration of lactates in rumen contents surge. Lactic acid is more acidic than VFA's, damage rumen epithelium directly and exerts osmotic pressure to draw drawn fluid from circulation into rumen, dehydrating the animal. The animal will develop diarrhoea with characteristic odour. Rumen motility ceases and affected animals will reject feed and water. The animals develop staggering gait, eventually become recumbent, slip into coma and die in the absence of proper Veterinary care. A related condition called sub-acute ruminal acidosis (SARA), occur when rumen pH remain between 5.2 and 5.6 for prolonged periods. Clinical signs are not visible or go unnoticed. Diagnosis is based on history, symptoms and testing of rumen liquor.

Laminitis

It si the inflammatory condition affecting hoof and is an important cause of lameness. The disease is associated with acute or sub acute acidosis. Low pH damages ruminal epithelium which results in the release of histamines and absorption of endotoxins into circulation. These compounds interfere with blood circulation inside hoof and cause laminitis. Cattle fed with high levels of crude protein may develop lameness induced by protein degradation products. Calcium, Phosphorus, Vitamin A and E are necessary for maintaining the integrity of hoof. Other trace minerals like Zinc, Selenium, Copper and Cobalt are also known to influence health of hoof. Supplementation of a good quality mineral mixture at adequate level is sufficient to address this problem.

In order to reduce the risk of acidosis, concentrates rich in carbohydrates should be introduced gradually over a period of 2-3 weeks. This process will provide adequate time for ruminal flora to adjust to the change in feed. The size of forage is also an important factor since finely chopped fodder may fail to stimulate enough salivation in ruminants. The ruminant saliva is rich in factors (eg. bicarbonate ions) which buffer acidity and maintain physiological conditions in the rumen. Sodium bicarbonate (baking soda) or magnesium carbonate could be included in ruminant rations to the level of 0.75-1 % by dry matter as a preventive measure.

Ketosis or acetonemia

It develops when energy utilization exceed intake or in conditions of net negative energy balance and is typically seen in early lactation. Subsequently body fat is metabolized to meet internal energy demand. The serum concentration of blood sugar decreases while that of fatty acids and metabolites of fat like acetone, acetoacetate and β-hydroxybutyrate (Ketone bodies) increases. Reduced

appetite, refusal of concentrates, reduction in milk yield, lethargy etc. without fever are the important symptoms of the disease. In some cases, nervous signs like excess salivation, licking incessantly or aggression develop due to derangement of brain function with low blood glucose level. Diagnosis is based on history, symptoms and laboratory tests to detect ketone bodies in urine.

Ketosis can be prevented by practicing 'steaming up' which basically elevates the plane of nutrition of an animal near calving period. Grain feeding is initiated one month before calving at the rate of 500 g per day to a final level of 0.5 Kg to 1 Kg per quintal (100 Kg) of animal's body weight. During immediate postpartum period, the ration should contain relatively higher level of non fibre carbohydrates (38-41%) with about 30% NDF. Feed additives like niacin, calcium propionate, sodium propionate, propylene glycol and rumen-protected choline included in rations from the last 2-3 weeks of gestation through period of susceptibility may help to prevent ketosis. Supplementing fat to the level of 2-3% of total ration will increase the energy density of feed. Nutritional support maybe extended up to a period of 4-6 weeks after calving, in which the animal attains peak yield.

Fatty liver

Disease is caused by negative energy balance. The disease is observed during the period between one week before and one week after parturition. It develops before and during parturition and is often associated with Ketosis. Physiological response to negative energy balance is the release of body fat into circulation. The liver retains about 15-20 % of this fat in the form of non esterified fatty acids (NEFA). Excessive accumulation of fatty acids in liver causes functional derangement, impairs immune response and predisposes the animal to periparturient diseases like mastitis or metritis. Reduced appetite, milk production and Ketosis are observable symptoms. Histopathological examination of liver biopsy is the most reliable method for diagnosis.

Occurrence of the disease can be prevented by increasing energy density of ration and by including additives which prevent accumulation of triglycerides in liver. Drenching propylene glycol or glycerine during the last week before parturition is an effective control measure. Administration of slow release insulin as injection or feed supplements which trigger insulin response are helpful due to antilipolytic action of the hormone. Incorporation of choline, monensin, chromium, niacin, conjugated linoleic acid etc. may also be useful in this regard. Low milk fat syndrome is the reduction in fat yield below expected levels with respect to the stage of lactation or genetic potential of the cow. Low fibre diet and high content of fat in rations are the important reasons for depression of fat content in milk. Diets with more than 28% starch predispose cows to reduction in milk fat. Roughage content of the ration should be at least 40%, with NDF content of about 20%. Roughage with long particles stimulate chewing and salivation. The buffering action of saliva favours the formation of acetate in rumen, which is the precursor for milk fat synthesis. Feeding of sodium bicarbonate at 0.7% - 1% level and Magnesium oxide at 0.35-0.40% levels in ration also improve milk fat content. Fat content shall be limited below 5% and if supplementation is inevitable, incorporation of high unsaturated fatty acids, bypass fat or calcium salts of fatty acids will reduce the risk of low milk fat syndrome.

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NON-DESTRUCTIVE TECHNIQUES FOR QUALITY EVALUATION OF FRUITS

1. Introduction

Consumers are now more conscious about quality and source of their foods. Attempts made to determine the quality of food materials are numerous, but most of them are destructive in nature. In recent years, nondestructive methods of quality evaluation have gained momentum and considerable attempts have been made to develop them. Fruits are increasing in popularity in the daily diets of people of both developed and developing countries. Product quality and quality evaluation methods are naturally extremely important. The decisions concerning harvesting maturity, ripeness and quality are based mostly on subjective and visual inspection of the fruit's external appearance. Several

nondestructive techniques for quality evaluation have been developed based on the detection of various physical properties that correlate well with certain factors of a product. The quality of fruits is mostly based on size, shape, color, gloss, flavor, firmness, texture, taste and freedom from external as well as internal defects.

Numerous techniques for evaluating the above external quality factors are now available commercially. Internal quality factors such as maturity, sugar content, acidity, oil content, and internal defects, however, are difficult to evaluate. Methods are needed to better predict the internal quality of fruits without destroying them. Recently, there has been an increasing interest in non-destructive methods of quality evaluation and a considerable amount of effort has been made in that direction. But the real problem is how these methods are to be exploited practically and what the difficulties are in implementing them. The objective of the present seminar is thus to review the application of the most recent non-destructive methods such as nuclear magnetic resonance, x-ray computed tomography, near-infrared spectroscopy and some other important methods and to evaluate their pros and cons for suitability in commercial application.

Nondestructive Quality Evaluation Technology: Quality evaluation methods can be the destructive and non-destructive. They include both objective methods based on instrument reading and subjective methods on human judgment. Various analytical methods are available for determination of quality related components using optics, X-ray, mechanics, and electromagnetic (Table below).

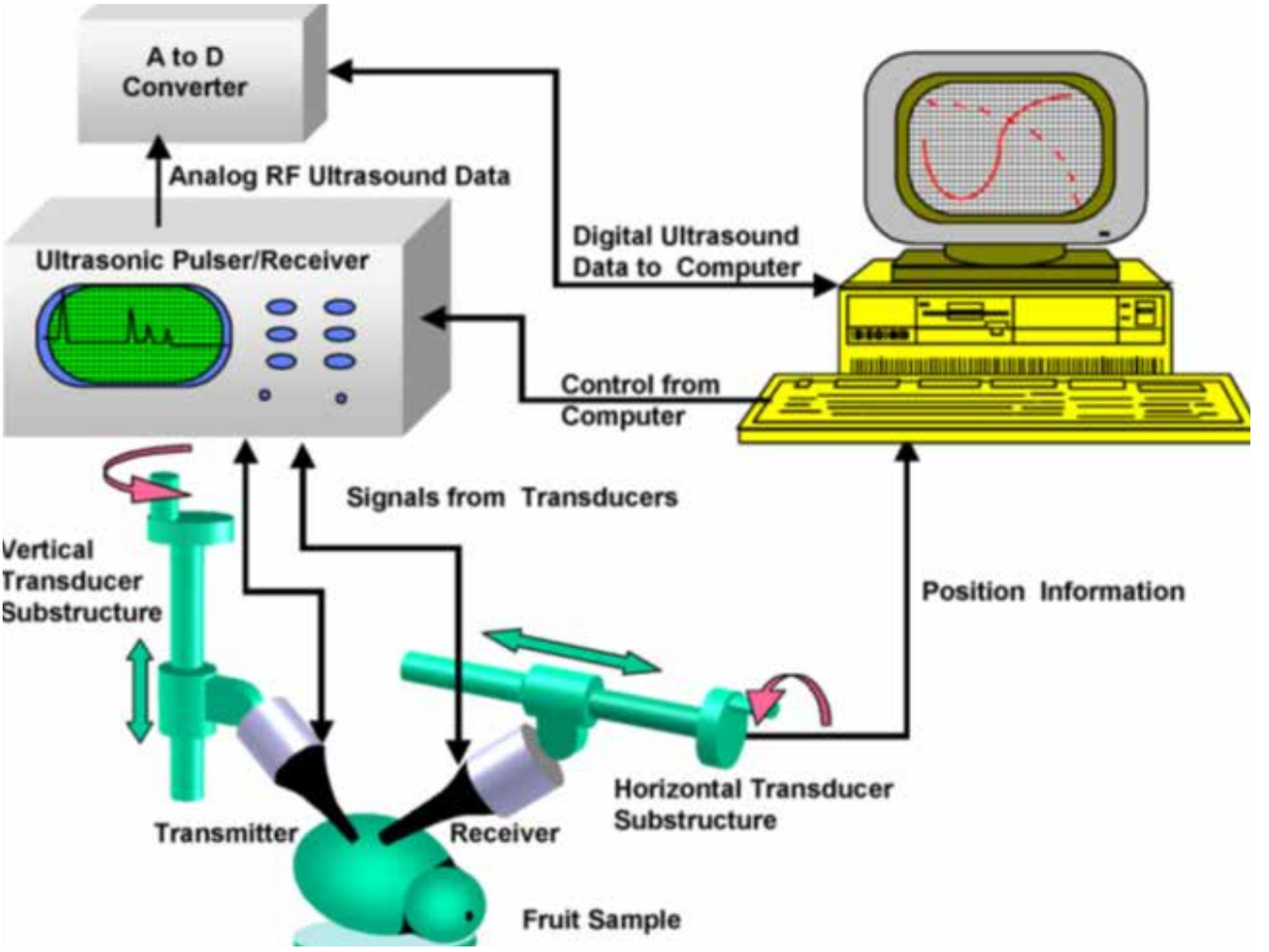
CONCLUSION:

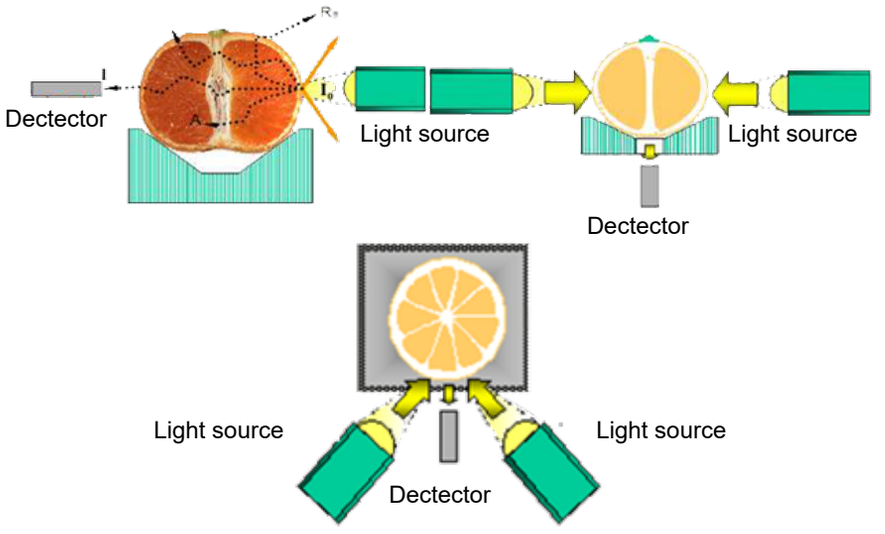
Determination of quality of any food material is actually a complex problem that requires a variety of specific sensors, more than an accumulation of simple sensors. Various techniques are being tried. NMR, x-ray CT, Ultrasonics, Acoustics, E-nose, Hyperspectral imaging and NIR techniques may be useful for a large volume of work in agriculture, especially for evaluation of qualities such as maturity, internal quality of fruit and conditions of food materials

Nondestructive Measurement of quality factors for horticultural produce

Methodology	Technique being used	Components
Optics	Image Analysis	Size,Shape colour, External defects
	Reflectance, Transmittance and Absorbance Spectroscopy	Internal Components Colour,Defects
	Laser Spcctroscopy	Firnnesss,Visco-Clasticity,Defects,Shape
X-ray	X-ray image and CT	Internal cavity and structure, ripeness.
	Vibrated Excitation	Firmness, Visco-elasticity, Ripeness
Mechanics	Sonic	Firmness, Visco-elasticity, Internal cavity, Density, Sugar Content.
	Ultrasonics	Internal cavity and structure, Firmness Tenderness.
Electromagnetic	Impedance	Moisture contents, Density, Sugar Content. Density, Internal cavity.
	MR/MRI	Sugar content, Oil, Moisture content Internal defect and structure.

Schematic diagram for continuous-touch ultrasonic system (Mizrach et al., 2000)





after processing.

Thus, the Non-destructive techniques of quality evaluation is gaining a good momentum in field as well as processing industries. But rapid and accurate determination of internal quality possess technical challenges because of complex structural, physical and chemical properties of fruits and vegetables. As these methods are instantaneous and can simultaneously determine many parameters, could be used for bulk handling of produce. Most of the developed countries are using various on farm non-destructive methods. But in India due to technological hitches and lack of development of equipment's and their availability, has restricted their wider usage in quality evaluation of fruits and vegetables. Research must continue to focus on making their use easier and lowering the cost to make it within the reach of common businesses / growers of both developed and developing countries. Therefore, the development of an accurate, reliable and nondestructive method for the quality evaluation before harvest and at packaging site is critical to provide better quality produce.

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Wheel Hoe Weeder

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Wheel Hoe Weeder (WHW) designed and developed by Department of Agronomy, College of Agriculture, Vellayani under Kerala Agricultural University has been granted patent by Government of India for ten years with effect from July 2021. It is a manually operated push-type machine with a wheel and weeding blade for weeding. The machinery can easily be operated for weeding in inter row spaces of row planted crops. The long handle lets the operator to avoid bending over to pull out the weeds. An operator using the machinery with weeding blade of sweep size 20 cm attached to it can weed an area of 0.015 ha (3.7 cents) in an hour in loamy soil.

The machinery is operated by pushing action through force exerted by operator on the handle bar with grips, which allows the soil working part of the machinery i.e. weeding blade to penetrate into the soil, skim below the ground surface and cut or uproot the weeds in between the crop rows. Soil mass to a depth of 1.5 cm is manipulated by the machinery during operation.

Distinguishable design features

Weeding blade is attached to headpiece such that the weeding blade is slanted to an angle of 15° to the horizontal while the headpiece remains vertically attached to chassis. This design is incorporated so that weeding blade can easily penetrate soil with least resistance.

The radius of the wheel measured from the centre of the axle to the outside edge of the wheel and the section measured from the middle of the fork to the outside edge of the weeding blade are both of same length.

Handle bar with grips is attached to the handle stay at an angle of 20° to the horizontal. This design provides the operator with more direct and accurate control over the soil working part of the machinery i.e., weeding blade. The square tubed chassis is a distinctive feature which acts as the main body of the machinery to which three important parts of the machinery viz. handle bar, ground wheel and weeding blade are attached using handle stay, fork and headpiece, respectively.

The chassis has provision to attach weeding blades of varying sweep sizes 10, 15, 20, 25 and 30 cm as per crop inter row space requirement.

Wheel Hoe Weeder has been developed as a part of doctoral/post graduate research programme of Seethal Rose Chacko, Dhanu Unnikrishnan, Krishnasree R K and Anitrosa Innazent under the guidance of Dr. Sheeja K Raj, Dr. Jacob D and Dr. Shalini Pillai P, Department of Agronomy, College of Agriculture, Vellayani.

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LET'S GROW THEM VERTICALLY TOO...

Homestead farming is one of the most popular cropping systems in Kerala. The main disadvantage faced by Keralites in this system is lack of available space. Increased urbanization contributes to this problem. This pandemic has pushed everyone to become self-sufficient at least for most vegetables. Maintaining vertical farming, therefore, seems to be the most practical option for an urban farmer. Vertical farming is an innovative way of maintaining our agricultural practices. It is the practice of growing crops in vertically stacked layers.

The main benefits of growing vegetables vertically are better air circulation, keeping the plant dry and free from rot and fungal diseases such as powdery mildew. The leaves can spread out and benefit from more sun exposure. Cucumbers grow upright when hanging from the vine rather than spreading on the ground. This can make harvesting hassle-free. The system aids in the early detection of pests and diseases, enabling us to adopt early management practices. With this system, good use of resources can be achieved. Especially less ground space will be used and this leads

to less weeding.

Cucurbits, peas etc. are some of the vegetables that are easy to grow upright. To begin with, we need a solid foundation to grow vegetables vertically, the next step is to train the plants and vines. Fortunately, it is not difficult, you just need to straighten yarn or coconut fibres and tie them well to the stand. Gently wrap or weave the plant's stems around the stand, keeping the tendrils clinging to it as they grow.

To support urban farmers, IFSRS, Karamana, operating under the umbrella of Kerala Agricultural University, has developed various vertical farming models, each with unique characteristics. The number of grow bags a structure can hold and the irrigation facilities vary from one another. With this system, one can grow commonly used vegetables such as amaranth, bhindi, tomato etc. Along with this structure, wick irrigation can be used. The Wick system is a watering method for potted plants that uses a soft fabric string known as a wick. A pipe is provided in this system and a wick is passed through it in such a manner that the end portion reaches up to the root of the plants.

This improves the efficiency of water use and makes it more adaptable even during the summer season. In addition to water, we use this system to provide diluted cow urine, diluted cow dung slurry, organic fertilizers and, if necessary, chemical fertilizers. Depending on the requirements, another ladder-shaped system can also be adopted. This system facilitates irrigation by holding a bucket into which the water can be poured and this water reaches the plants with the help of a drip irrigation system. Such a structure can cost a minimum of Rs 7000 to a maximum of Rs 15000. But it can be of great benefit if space is the problem that prevents you from growing chemical-free vegetables in your homestead.

We can select a suitable system taking into account our requirements, available space budget.These systems have been widely used in different parts of our country and have now become the necessity of the hour. The pandemic has now heightened our curiosity about the route of harvesting from farm to store. So this situation suggests growing vegetables in our homes and we do not have space for horizontal cultivation

So let's grow them vertically.....

Weed management in Wheat under conservation Agriculture

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Weed management is an essential part of the agriculture production system and conservation agriculture (CA) requires special attention for that. Based on habitat, weeds act differently.

"Tillage" provides different habitat for weeds by manipulating and changing the microclimate of soil and play an important role in weed management. Weed management in CA depends upon good agronomical practices, use of herbicide and tillage level. In Indian, the rice-wheat cropping system comprises major area. However, under the conventional tillage system, this cropping system facing major problems like land degradation, excess energy losses, rice straw burning, delayed wheat sowing and reduced crop yield. To solve these issues, conservation agriculture is the best feasible option. However, care should be taken to manage the weeds under CA.

Conservation agriculture (CA)

According to FAO, CA is an approach to manage agro-ecosystems for improved and

Fig 1(a). Sowing of wheat crop by zero till seed drill

Fig 1(b). Retention of previous crop residue under zero tillage

sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. This includes three principles viz., continuous minimum mechanical soil disturbance [Fig 1(a)], permanent soil organic cover Fig 1(b)] and crop diversification.

Weed shift in conservation agriculture

The shift in weed flora occurs by conversion of conventional to conservation tillage systems. It depends on the frequency of tillage by disturbance of the soil surface. It was observed that under the zero tillage system, gramineous weed are favoured more than the other weed species. Also, crop residue retention and its incorporation under CA influence weeds composition.

Weed control measures under CA

Conservation practices viz., crop residues, crop rotation, herbicide use, integrated weed management (IWM) are well fitted for weed management under CA.

Crop residues

Crop residues, its quantity and allelopathic properties affect the weed seed germination and its emergence. In CA, mulch on the soil surface suppresses weed seed germination by reducing the light transmission and their allelopathic effect. Delayed weed emergence provides crops to take a competitive advantage over weeds.

Incorporation of crop residue of t/ha or more helps in the reduction of weed emergence and its biomass by 50% compared to the conventional system (Fig 2). Along with this, it helps in moisture retention, lowering the soil temperature and increases the soil organic matter content.

Crop rotation

Crops rotation will alter selection pressures than preventing one weed spp. to remain dominant in a particular regime.

It alters selection pressures via. three mechanisms viz. altering management (e.g., agronomical means), different patterns of resource competition, and allelopathy. Each crop has unique architecture and involves variable management techniques that generate different microclimates. Mimic weeds can successfully be eradicated by rotation.

Herbicide use

Herbicides are one of the effective and economical way for managing weeds under CA system. Its efficacy under CA system depends on the suitability of herbicide, application time (either pre- or post-emergence) and the amount of crop residue on the soil surface. Under CA, post-emergence (PoE) herbicides are more effective as crop residue on soil surface dilutes the effect of pre-emergence herbicide.

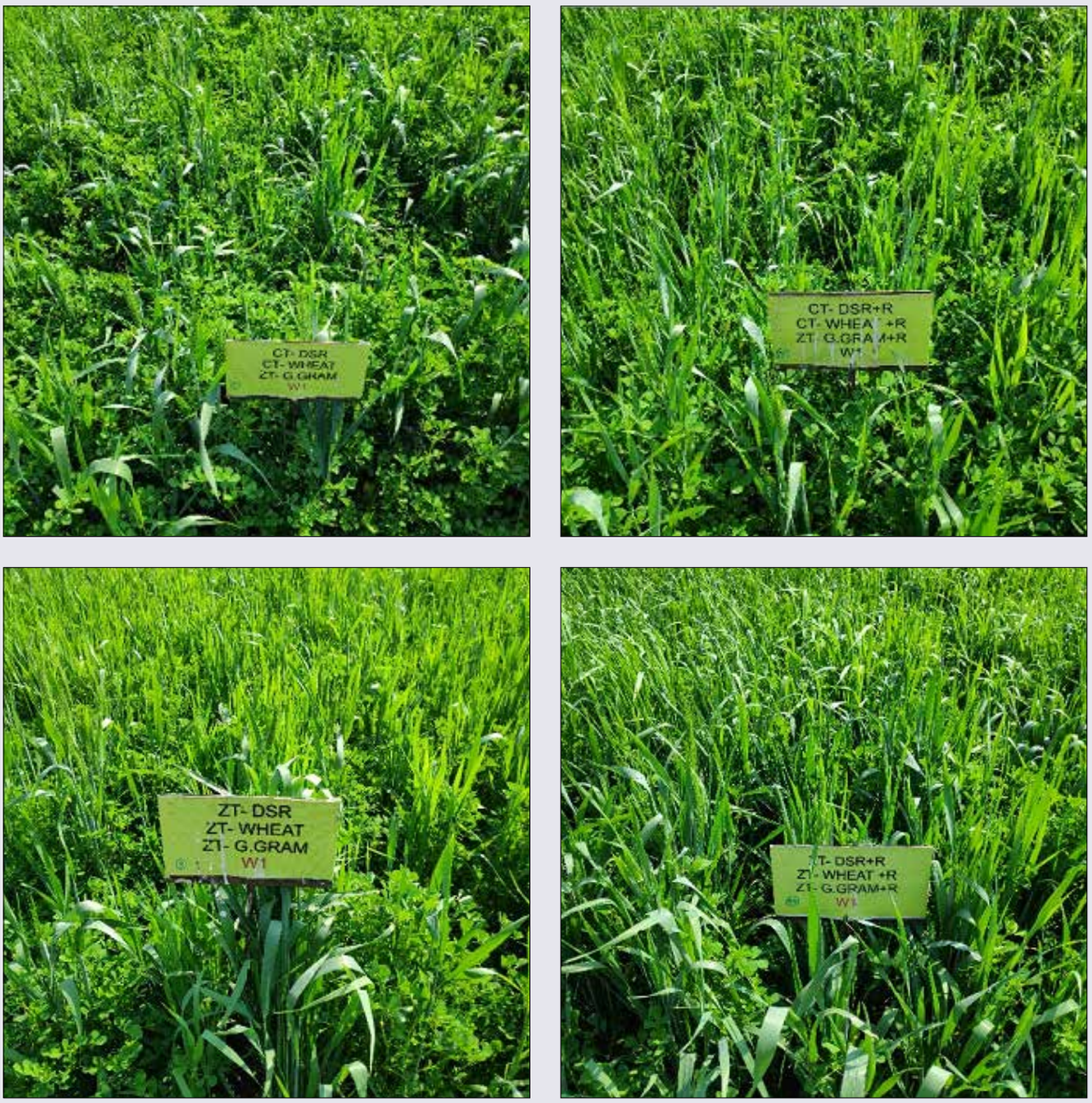

Fig 2. Weeds dominance in wheat field under different crop establishment methods (a) conventional tillage (b) conventional tillage + residue (c) zero tillage (d) zero tillage + residue

Weed management in wheat crop under conservation agriculture

Wheat (*Triticum aestivum L.)* is the second most important food grain crop of India with huge socio-economic importance. In the north-western part of India, the major cropping system is rice-wheat cropping. However, under the conventional system of the rice-wheat cropping system, farmers are facing major problems like rice straw burning, delayed wheat sowing, aberrant climatic conditions like cold injury, terminal heat stress, depleting water table, increasing fossil fuel emission depleting natural resources etc. These problems require suitable mitigation measures through proper crop establishment methods, residue management and weed management. To solve the above problems, an experiment was conducted at ICAR-DWR Jabalpur 2018-19 to know the effect of conservation agriculture and weeds management on weed dynamics and wheat crop yield.

The result indicated that

Fig 4. Effect of crop establishment methods on root architecture of wheat

wheat crop with rice crop residue retention under conventional tillage and zero tillage resulted in a 23% and 20% reduction in weed biomass, respectively. However, the application of PoE herbicides viz., clodinafop propargyl 60 g/ha+sulfosulfuron 25 g/ha (tank mix) and clodinafop propargyl+metsulfuron methyl 60+4 g/ha (ready mix) resulted in 50-65% and 83- 90% reduction in weed dry biomass irrespective of crop establishment methods, respectively.

Wheat crop performance under CA

It was observed that crop establishment methods with rice crop residue's retention on the soil surface, enhance the soil pore space with the addition of organic matter and retention of soil moisture that ultimately helps in improving root proliferation and good crop growth (Fig 4). The result indicates that wheat crop yield under zero tillage with residue retention was 17% higher than the conventional tillage system. Whereas, application of PoE herbicide clodinafop+metsulfuron (60+4 g ha -1) under zero tillage with residue retention as recorded grain yield 5046 kg/ha that is 36% higher than its unweeded check. Fig 4. Effect of crop establishment methods on root architecture of wheat

Conclusion

Conservation agriculture is the best feasible option to manage the agro-ecosystem with improved crop yield. However, weeds are the major factor that needs to be managed under CA. Sowing of wheat crop by zero till seed drill with the incorporation of rice crop residue helps in the suppression of major weed flora along with improving soil physio-chemical properties. In order to receive sustainability under rice-wheat cropping system, it was advisable to adopt zero tillage with residue retention along with the application of post- emergence herbicide.

Acknowledgment

The authors extend sincere gratitude towards ICAR-Directorate of Weed Research, Jabalpur for providing all Institutional support.

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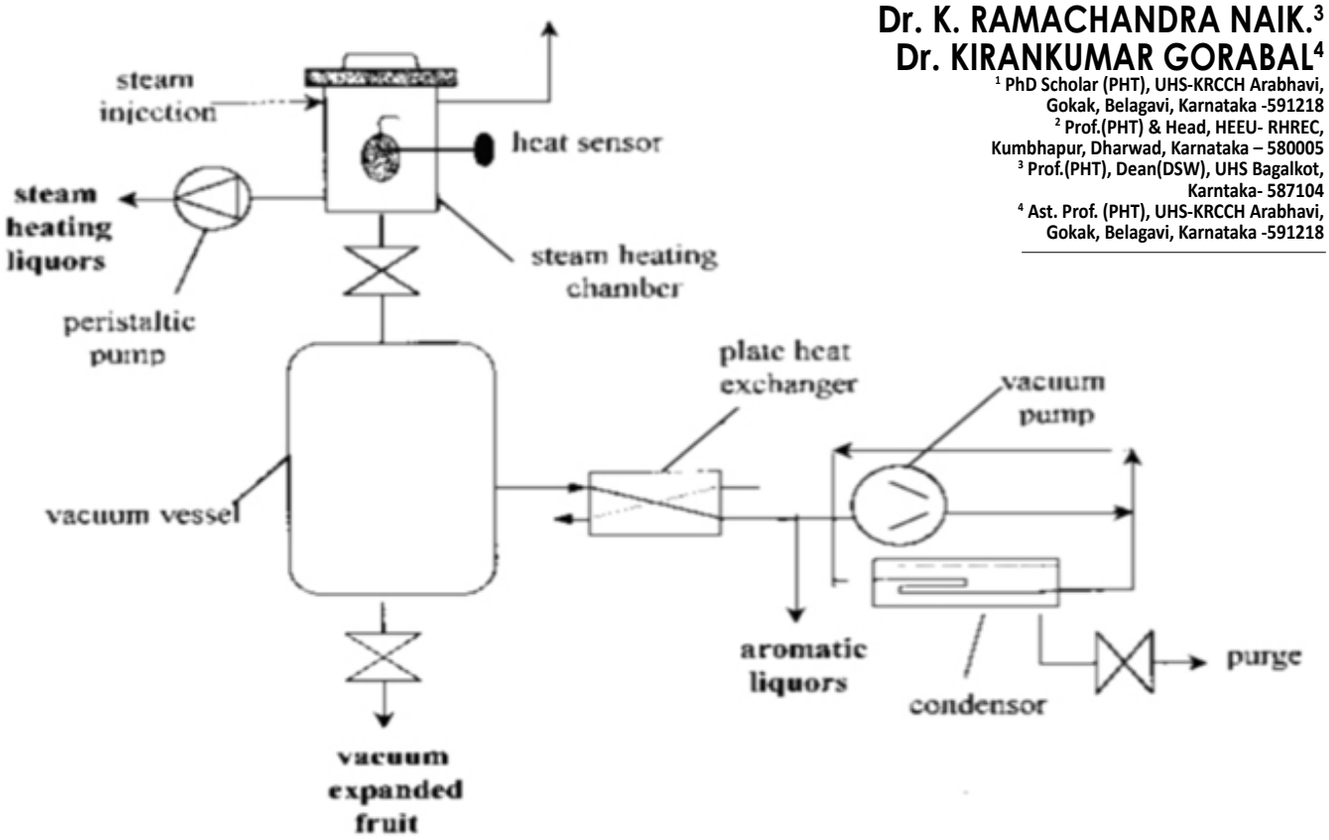
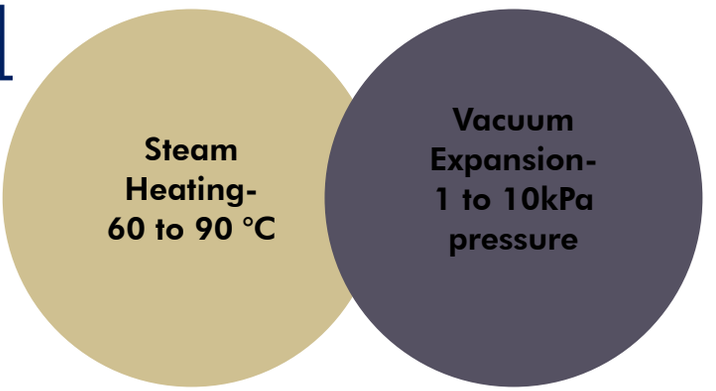


Flash vacuum expansion (FVE) A novel food processing technology

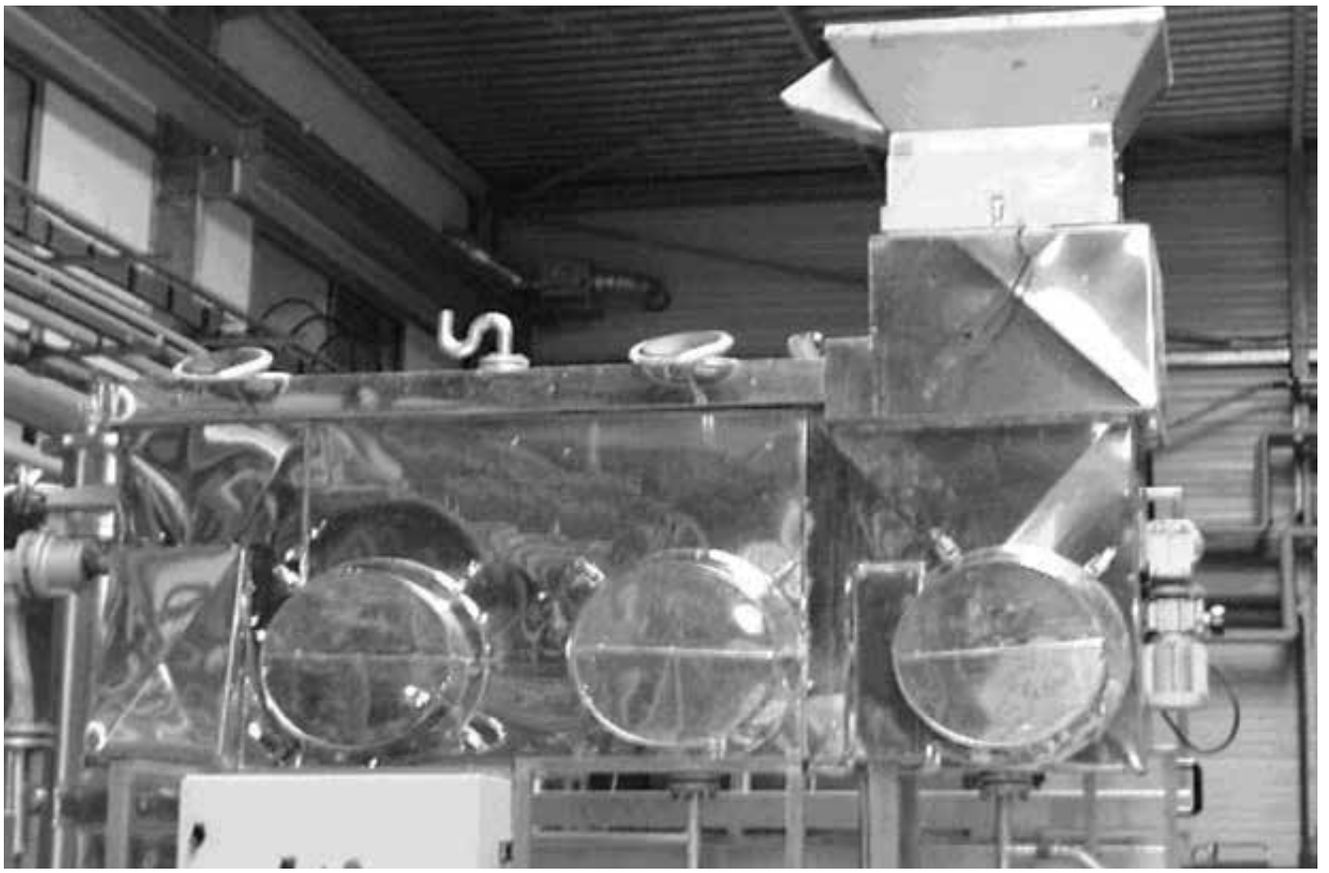


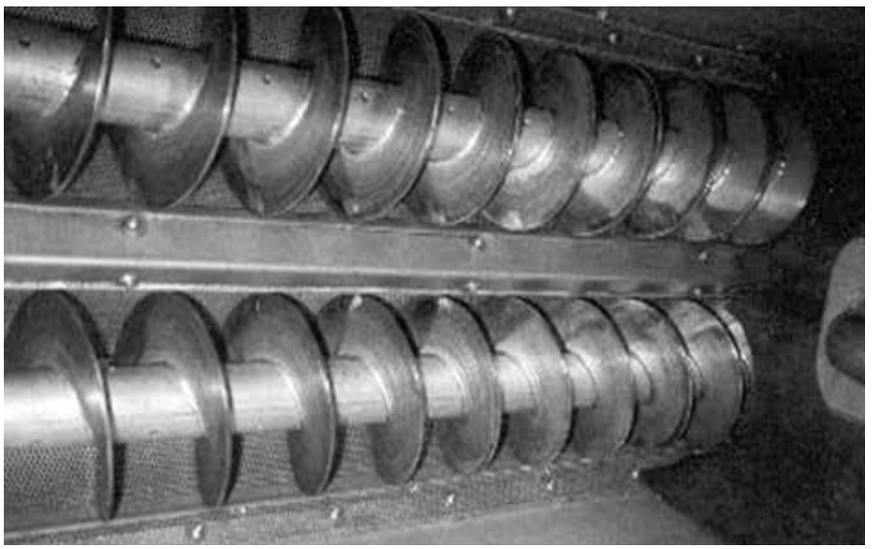
Due to consumer and industrial demands for healthy, convenient, fresh and quality food with high yield, processing of fruits and vegetables by different novel method is rapidly expanding now a days. Flash vacuum expansion is one such technology for extraction of healthy and quality products efficiently. Today it is increasingly used as a pre-treatment of grapes before fermentation or for production of tomato puree.

Flash vacuum expansion-

Flash vacuum expansion is a process where a heated

Components of Flash vacuum- expansion process





Steam heating chamber of F.V.E process.

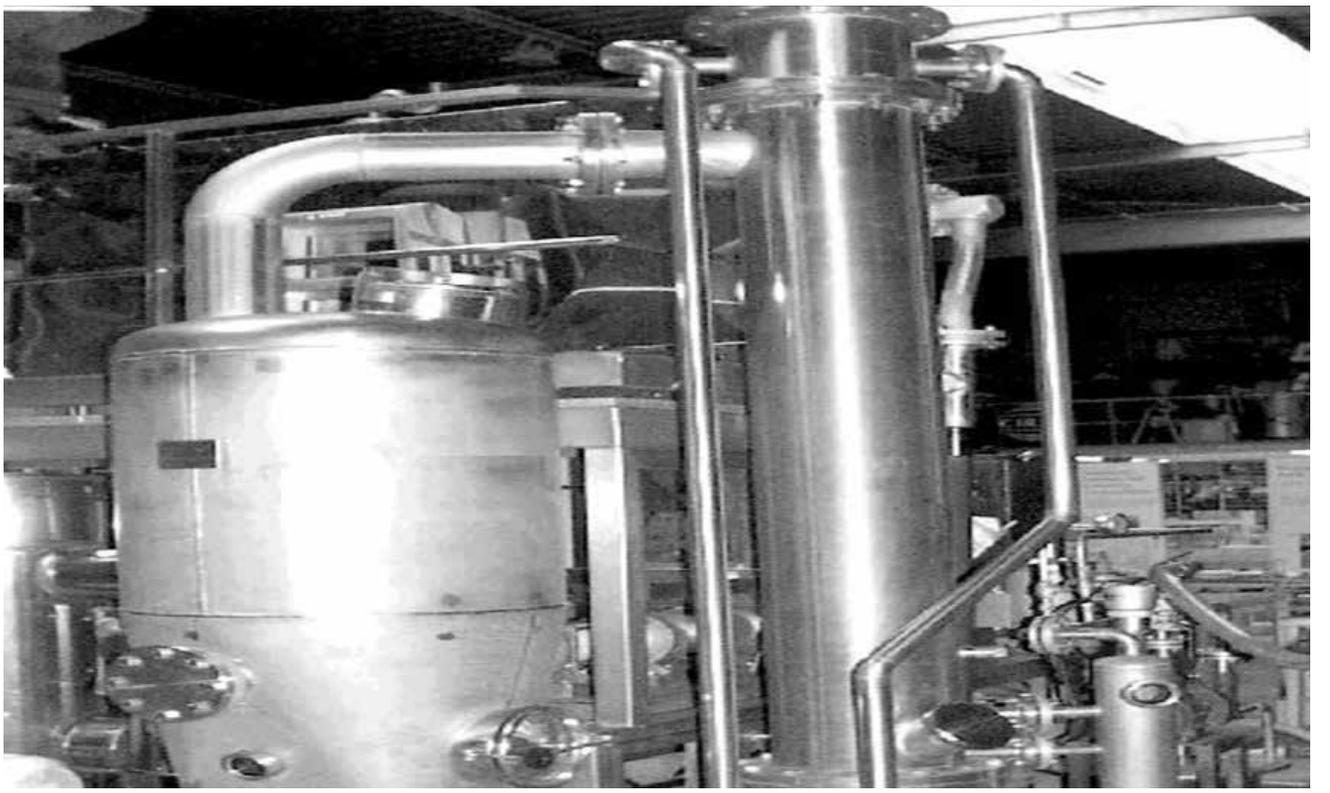
product is rapidly exposed to low pressure, or vacuum, causing interstitial water in the product to rapidly flash and rupture a portion of the tissue. This process has potential to aid expression and improve extraction of potentially healthy components from fruits and vegetables.

Working principle-

Flash vacuum expansion (or flash release) is technology developed to improve yield, nutritional and sensory quality of food products. In this technique, plant materials are steam heated to 60-90 °C and is rapidly introduced to a vacuum chamber at 1-10 kPa. absolute pressure. At this reduced pressure (high vacuum), the boiling point of water in the tissues is much lower than the temperature of the plant material (60-90 °C). Due to formation of micro channels inside the tissues, instantaneous evaporation of constituent water occurs.

Steps in FVE process

There are two steps involved in the flash vacuum expansion process, they are steam heating at 60- 90 °C and immediately followed by vacuum expansion stage with highest vacuum and reduced pressure of 1-10 kpa. The vacuum expanded food is collected at the collecting end of the system and the evaporated water is collected in condenser and liquified by using the cooling agent. The aromatic liquid thus obtained is collected and stored for the



Vacuum chamber and recovery system

further use.

Flash vacuum expansion is based on lowering the boiling point of water at reduced pressures. For example, at 1kPa (absolute), the boiling point of water is 7 °C. When fruit at 90 °C is exposed to this pressure, the water in the fruit cells boils violently causing a 'flash'. The evaporating water takes the heat of evaporation from the fruit, cooling it in the process. The system equilibrates when the vapor pressure of water in the fruit matches the pressure of the chamber (boiling point at that pressure). This sudden and instantaneous evaporation causes a rupture of cell walls and is hypothesized to increase the concentration of cell components in the juice.

It is consisted of a cylindrical stainless steel steam-heating chamber (f = 12 cm; h = 24 cm; v = 2.7 L, Figure 1) fed at normal pressure with a water-steam generator and coupled through a manual pneumatic valve (103 kPa; opening time 0.5 s) to a cylindrical quartz vacuum vessel (f = 30 cm; h = 48 cm; v = 34 L) where vacuum (3 kPa) is generated by a vacuum pump cooled by a closed water circuit connected to a condenser. Steam-heating liquors, generated by condensation of steam on the fruit and by exudation of some inner juice, are collected at the base of the steam-heating chamber.

Aromatic liquors, generated by the instantaneous evaporation of water and volatiles, are collected after passage on a plate exchanger.

Applications of flash vacuum expansion- in food processing industry

- For extraction of pulp
- For processing of puree
- For extraction of grape juice and increased expression of anthocyanin concentration
- In extraction of the essential oils from fruits, vegetables and other plant products
- In the wine production industry as an alternative for maceration step
- In minimal processing of avocado and other fruits
- In extraction of secondary metabolites from various plant parts
- In production of the dehydrated chips from fruits and vegetables etc.

FVE application in fruit & vegetable Processing-

Paranjpe et al. (2012) studied the effect of a flash vacuum expansion (FVE) process on grape juice yield and quality, where they found out that FVE process gives significantly highest yield (75.55g/100g), total polyphenols (5.69mg/g) and lowest magnitude of the

impedance (8.72kU) than the conventional enzyme processing and control in Thompson seedless grape.

Preparation of passion fruit puree by flash vacuum expansion was studied by Brat et al. (2001) where a puree was obtained about 50 per cent/ fruit weight yield, which was 2 fold than that obtained for the reference juice(passion fruit juice obtained by conentional juice extractor) and also found to have higher consistency and viscosity than reference puree. Manuel et al., (2016) studied on effect of thermal stage in the processing of avocado by flash vacuum expansion which effect on the antioxidant capacity and the quality of the mash. They found that lipoxygenase activity reduced by up to 70 per cent and the antioxidant capacity of the mash obtained by flash vacuum expansion remained stable for 15 days without adding preservatives.

Pierre et al. (2001) studied on the essential oils obtained by flash vacuum expansion of peels from lemon, sweet orange, mandarin and grapefruit. Peel essential oil yields were (2.41, 1.43, 0.64 and 0.73) kg per ton of fruit for lemon, sweet orange, mandarin and grapefruit, respectively, The FVE process allowed production of citrus peel essential oils with yields were comparable to the Food Machinery Corporation process. Oils were enriched in monoterpene hydrocarbons and correlatively impoverished in oxygenated volatile constituents. Marco et al. (2019) studied on flash vacuum expansion process: effect on the sensory, colour and texture attributes of avocado puree, and found that the puree possessed highest sensory score for grainy texture (7.68), colour (6.55), fibrous (5.23) and nutty (3.05) and least score for homogeneity (3.64), fatty (4.86) and unctuous (4.73) descriptors. Available literatures on the flash vacuum expansion process prove its wide range of application and advantages over traditional processing methods.

Advantages of flash vacuum expansion

- Improved yield in terms of juice and puree
- Improved expression of phytochemicals, polyphenols and other beneficial compounds
- Improved rheological and textural properties
- Higher extraction of essential oils and volatiles
- It will help in reducing the time than the conventional methods
- Can be used as alternative to maceration technique in wine preparation
- Fastening the drying with excellent dehydrated products with short time
- Extension in preservation period
- Improved color and other sensory parameters

Conclusion

Flash vacuum expansion (FVE) is a technology with potential for extracting more phytochemicals from fruits, vegetables and other plant products.

The technology also showed improved yield, increased content of anthocyanin, polyphenols, plant volatiles and beneficial phytochemicals when compared to the conventional processing methods without affecting the rheological and sensory quality parameters

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