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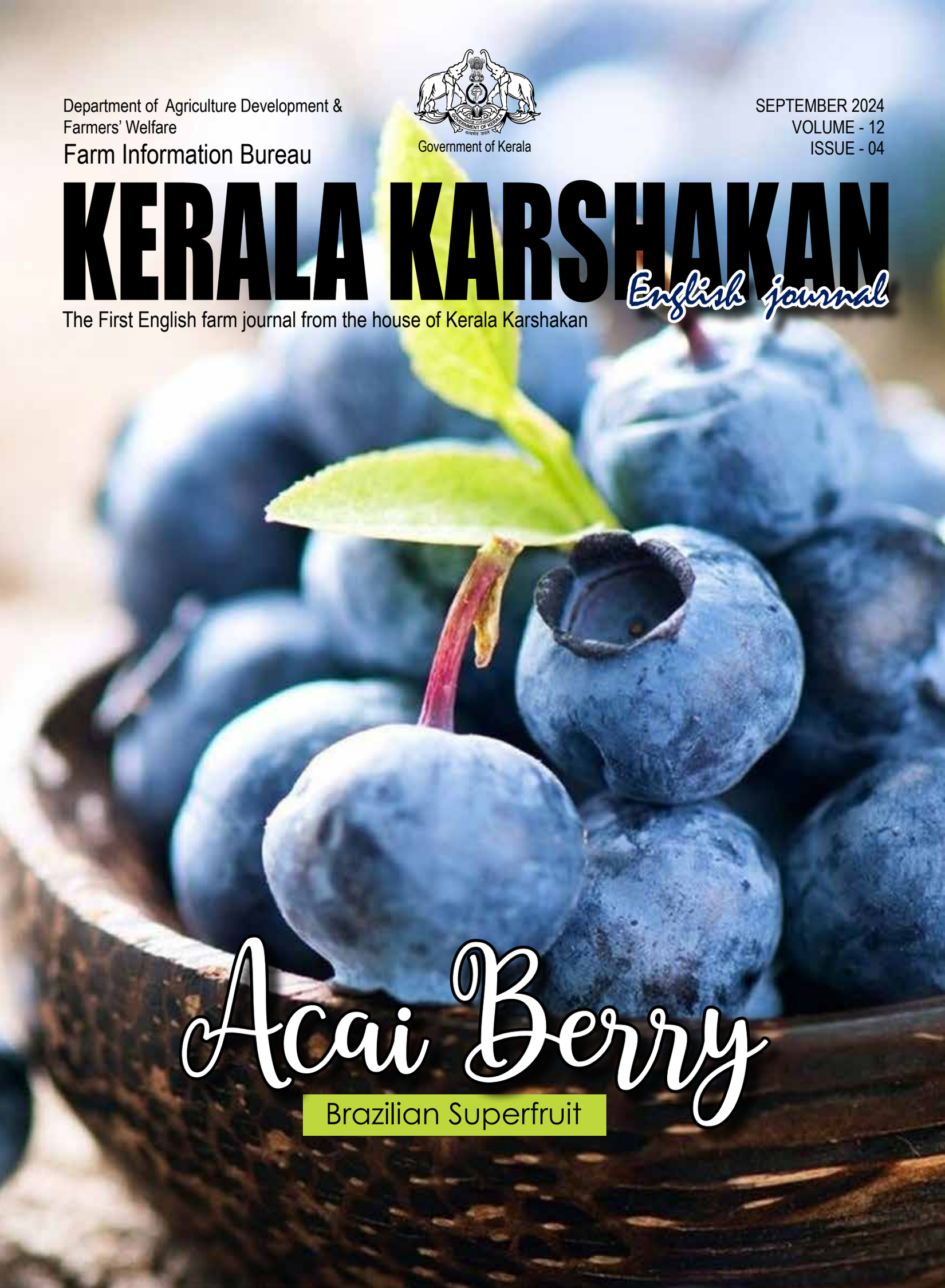
English journal

The First English farm journal from the house of Kerala Karshakan



Acai Berry

Brazilian Superfruit

INSIDE KERALA KARSHAKAN

English journal

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Acai Berry

Brazilian Superfruit

Acai Berry (*Euterpe oleracea*) is a tropical fruit from the Amazon region of South America, known for its high free radical scavenging capacity and status as a 'superfood'.

PLANT DESCRIPTION

Tree:- 4-8 slender grey-brown stems (25 meter tall, 20 cm in diameter), bears ring-leaf scars and are topped with a crown of

9–15 compound leaves.

Leaves:- Pinnate leaves measure about 1.2–4 meters long.

Flowers:- Small brown-purple, either staminate or pistillate, and borne on large branching inflorescences, hang from the top of the stems. The flowers are pollinated by small bees and flies.

Fruits:- Round drupes known as "acai berries", resembling grapes but smaller with less pulp. Produced in branched clusters of 500 to 900 fruits, about 1.5 cm in diameter with a single large seed. They usually ripen from green to a deep purple. Each acai stem can produce up to eight bunches of fruit a year, each bunch weighing up to 6 kg.

NUTRIENT COMPOSITION

A powdered preparation of freeze-dried acai fruit pulp and skin contains 534 calories, 52 g carbohydrates, 8 g protein, and 33 g total fat per 100 g of dry powder. The carbohydrate content includes 44 g of dietary fibre with low sugar levels, while the fat content is composed of 56% oleic acid, 24% palmitic acid, and 13% linoleic acid. Additionally, the powder provides 260 mg of calcium, 4 mg of iron, and 1002 IU of vitamin A per 100 g.

CULINARY USES

Fruits:- Acai berries are macerated in water to separate their seeds, producing a thick, purple pulp consumed directly or used in drinks and food products. Despite being highly perishable, acai is traded in dry or frozen forms. Fresh pulp is used in sweets, beverages, and wine, often mixed with tapioca.

Palm hearts:- Palm hearts are harvested by removing the growing top of the palm crown, each heart consists of a whitish cylinder of tender immature leaves which is used as vegetable.

Acai oil:- Suitable for cooking or as a salad dressing, but is mainly used in cosmetics such as shampoos, soaps, or skin moisturizers. Acai oil is green in color, has a bland aroma, and is high in oleic and palmitic fatty acids.

MEDICINAL USES

Boost immunity: Acai berries are rich in antioxidants, especially anthocyanins, which aid in neutralizing harmful free radicals in the body.

Heart Health: Anthocyanins regulate blood cholesterol by

reducing bad cholesterol (LDL) and assist in lowering blood pressure.

Digestive Health: The antioxidant and fiber content of acai berries helps to regulate bowel movements and eliminate harmful toxins from the body.

Brain Health: Acai berries support brain health with their abundant nutrients, including polyphenols, iron, vitamin E, and unsaturated fatty acids.

Skin health:- Antioxidant properties of acai oil used to relieve irritation and redness and moisturize the skin.

Weight loss:- The high fiber content of acai berries helps curb appetite and prevent hunger pangs linked to overeating and weight gain. They aid in maintaining a healthy weight by mitigating the adverse effects of high-fat diets.

Wound healing:- Acai berries have anti-inflammatory properties and therefore acai berry water extracts have promising effects on expediting wound healing.

OTHER USES

- Leaves of the palm are made into hats, mats, baskets, brooms, and roof thatch for homes.
- Trunk wood, resistant to pests, used for building construction.
- Acai seeds are ground for livestock food or as a component of organic soil for plants.
- Its anthocyanins are characterized for stability as a natural food coloring agent.

HEALTH RISKS

- Consuming unprocessed acai juice is associated with a parasitic illness called Chagas disease, which can lead to severe heart and stomach issues.
- Excessive intake of fiber-rich foods, like acai berries, cause gastrointestinal discomfort.

INSECT MINIATURIZATION
CONCEPT AND APPLICATION

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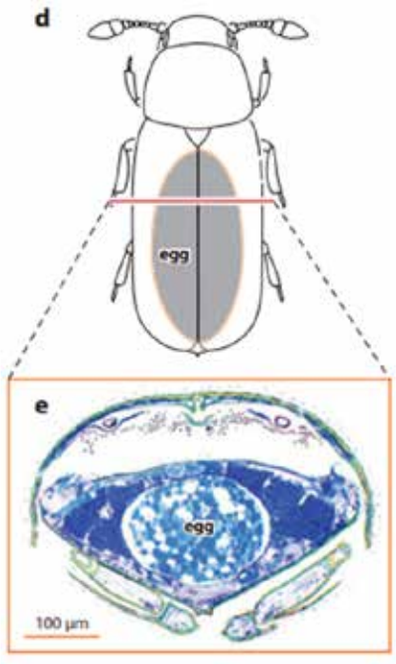
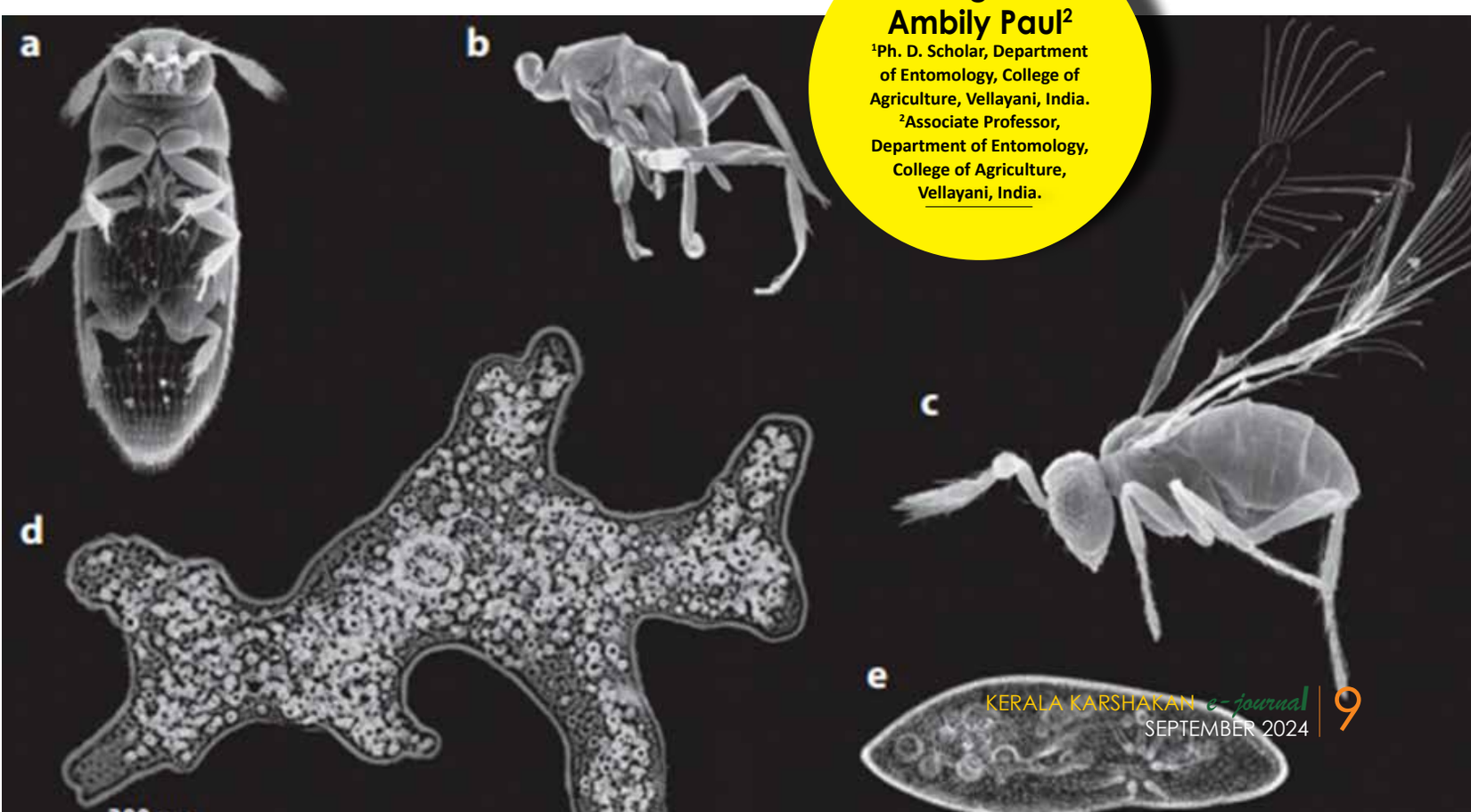
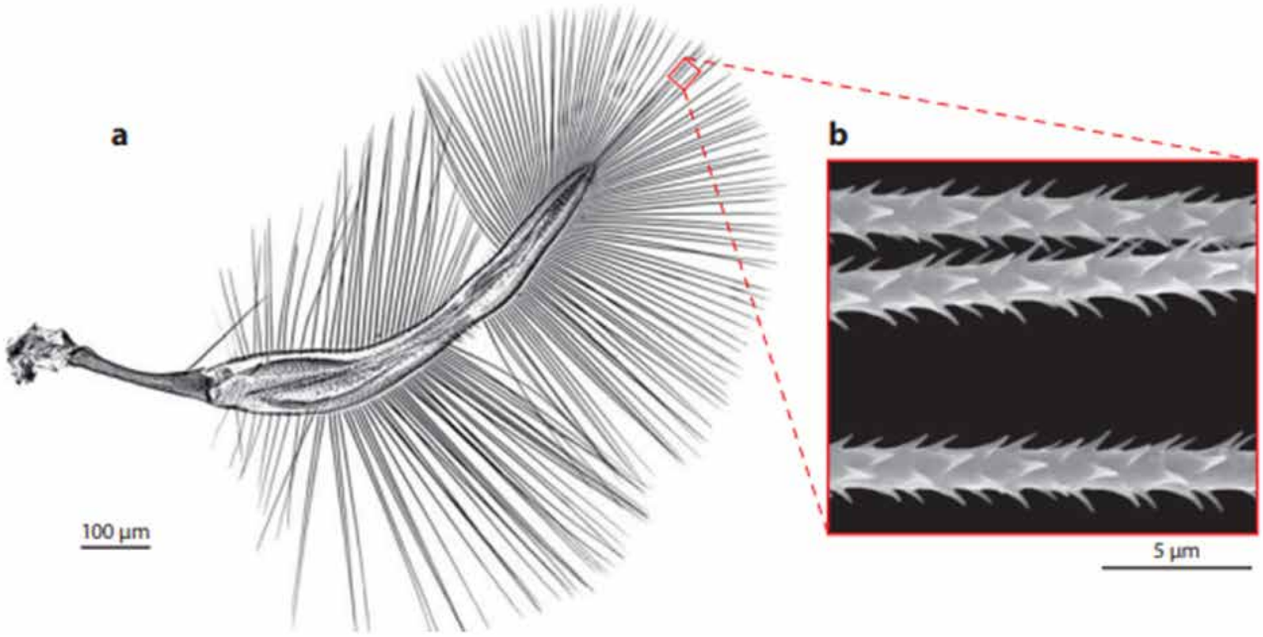
According to different studies, multicellular organisms tend to become smaller and smaller through time. This phenomenon is called miniaturization. Miniaturization or body size diminution, is a widespread trend of animal evolution and one of the principal directions of evolution in insects, some of which have become comparable in size to unicellular organisms. It involves not only small body size, but also the consequent extreme size reduction in anatomy, physiology, ecology, life history and behaviour and is a driving force for diversity and



Egg of *Porophilla mystacea* (Ptiliidae)

Relative body sizes of the smallest insects and unicellular organisms: (a) *Nanosella sp.,* (b) *Dicopomorpha echmepterygis*, (c) *Megaphragma mymaripenne*, (d) *Amoeba proteus,* (e) *Parameciu caudatum*.





Wing of *Acrotrichis montandoni* (Coleoptera: Ptiliidae)

evolutionary novelties, even though it must deal with some limitations.

Factors promoting miniaturization

Factors promoting the evolution of miniaturization are many specialized niches or habitats that demand tiny body sizes, such as the spaces between sediment particles, life as external parasites or commensals on parts of already small organisms or as commensals, inquilines or internal parasites.

Smallest insects

There are at least 245 families of the class Insecta that include representatives of body length smaller than 2 mm and at least 106 families of this class that include representatives 1 mm long or smaller. About 52% of all families that include insects of 2 mm long or smaller represent either the order Coleoptera or the order Hymenoptera. The smallest insects are the wingless males of the egg parasitoid, *Dicopomorpha echmepteryg* is with a body length of 139 µm(Fa- Mymaridae); the smallest flying insects are female wasps of *Kikiki huna* with a body length of 160 µm (Fa- Mymaridae) ; and the smallest nonparasitic insects are beetles of the genus *Scydosella musawasensis* (Fa- Ptiliidae) with a body length of 300 µm. Principal families of miniature insects are Liposcelididae (Order: Psocoptera), Thripidae (Order: Thysanoptera), Ptiliidae (Order: Coleoptera), Corylophidae (Order: Coleoptera), Mymaridae (Order: Hymenoptera) and Trichogrammatidae (Order: Hymenoptera).

Morphological effects of miniaturization on different organ systems Cuticular Structures

The cuticle is thinner in microinsects than in larger insects. *In Mikado* (Fa- Ptiliidae), the average cuticle thickness is 1.9 µm in adults and is 0.68 µm in first instar larvae. The males of Dicopomorpha echmepterygis (Fa- Mymaridae), has no mouthparts. The number of tarsomeres is smaller in the majority of microinsects than in larger members of related groups. The wing apparatus of the majority of microinsects is characterized

by developed ptiloptery and reduced number of veins. The main plane of the narrow wing is formed by long setae running along the perimeter. In Ptiliidae, these setae bear numerous processes, which probably serve to increase the total area of the wing.

Musculature

Effects of miniaturization on musculature in insects are rather minor. Degeneration of muscles in *Serricoderus lateralis* (Fa- Corylophidae) probably occurs during the adult life and is caused by the development of the reproductive system.

Digestive System

The majority of microinsects lack crops and gizzards as observed in *Acrotrichis montandoni and Ptilium myrmecophilum* (Fa- Ptilidae). The number of Malpighian tubules is three in Mymaridae and Trichogrammatidae while other Chalcidoidea have six.

Circulatory System

The circulatory systems of the smallest insects are greatly simplified with no vessels or pulsatile organs, except for the simple heart and short aorta. With small body size in Ptiliidae, the effective circulation of haemolymph is hampered by capillary forces. Due to this their hearts are reduced and the haemolymph is replaced by the fat body.

Tracheal System

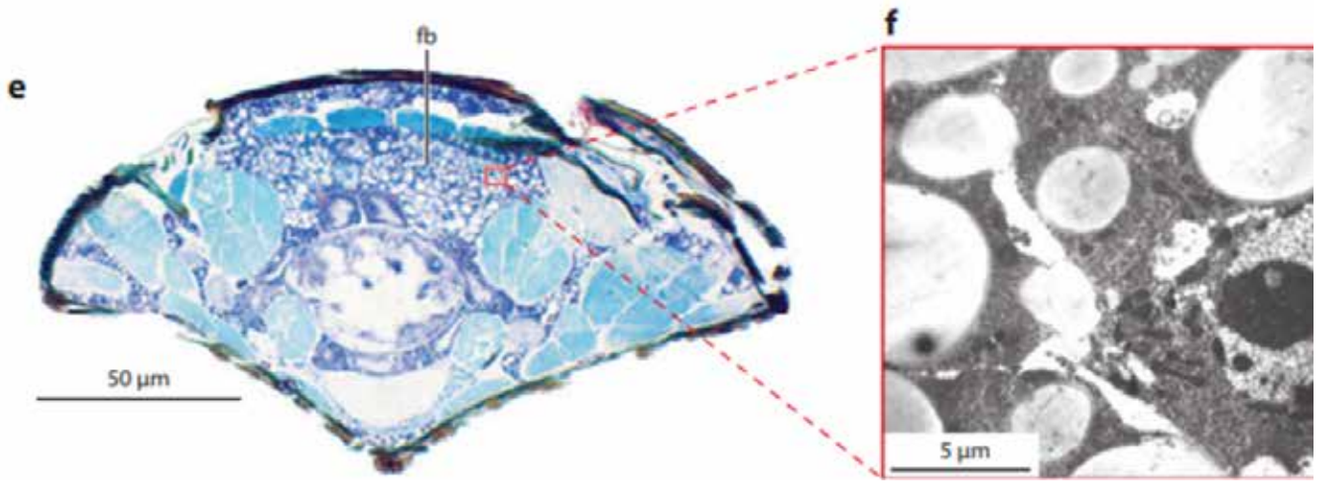
The number of spiracles is smaller than in larger insects. Only one pair of spiracles is present in larval Ptiliidae and spiracles are absent in larval Trichogrammatidae and Mymaridae.

Central Nervous System

All microinsects display strong oligomerization and concentration of ganglia. In Corylophidae, there is complete shift of the head ganglia into the thorax at the adult stage, which is related to a specific defensive adaptation when disturbed, Corylophid beetles pull in their very flexible head under the dome-shaped pronotum.

Asymmetry of central nervous system is observed in microinsects. The adults of the smallest Ptiliidae (Nanosellini) have asymmetrical distal processes of the protocerebrum, the left process is larger than the right process.

Decrease in body size is accompanied in all studied insects by a considerable decrease in the size of cells in the nervous system. The average neuron size of the smallest insects is about 2 μm. The decrease in neuron size in the smallest insects is accompanied by considerable changes in the nuclear-cytoplasmic ratio.



Fat body of Ptiliidae: adult *A. montandoni*, cross section of mesothorax.

Sense Organs

Decrease in body size in insects is accompanied by a considerable decrease in the number of sensilla. This decrease is especially visible in the antennae. In *M. mymaripenne* (Fa-Trichogrammatidae) each antenna bears only 38 sensilla, whereas in the other Chalcidoidea each antenna bears more than 1,000 sensilla. In the smallest insects, each eye contains only 30 ommatidia. The smallest known ommatidium in insects is 6 μm in diameter in *Trichogramma* evanescence and in the other Chalcidoidea the diameter is from 8 to 13 μm.

Reproductive System

The structure of the reproductive system of the majority of microinsects shows little difference from that of larger insects. In Mymaridae, the reproductive system is asymmetrical, with one gonad considerably larger than the other. In male and female Ptiliidae, only one gonad is present. In some species of Ptiliidae spermatozoa are even longer than the body.

Limits to miniaturisation

Nervous system

The dramatically increasing relative volume of the central nervous system in the smallest insects not only limits the body construction geometrically, but also leads to strongly increasing metabolic expenses.The relative volume of the central nervous system can reach 11.8% in adults (*Trichogramma evanescence*) and 16.75% in first instar larvae (*Liposcelis* sp.).Retaining a considerable number of neurons and maintaining a reasonable diameter of processes is required for performing the functions of the central nervous system.

Reproductive System

It is probably the minimum size of the egg that limits the further miniaturization of beetles. In Staphylinoidea, the relative egg size increases by a factor of more than six with decreasing body size. In Ptiliidae, only one egg develops at a time, occupying more than half the body length of the female.

Sense organs

One of the effects of miniaturization on sense organs is the dramatic reduction in the number of structural units (sensilla, ommatidia), but the size of particular sensilla and ommatidia changes only slightly.

Applications of Insect Miniaturization

- Insect locomotion is studied for developing tiny winged drones. They are used for monitoring, surveillance, search and rescue.
- A unique structure of the nervous system has been found in one of the smallest members of the family Trichogrammatidae, *M. mymaripenne*. The central nervous system of the pupa in this species contains 7,400 nuclei. At the final stages of pupal development, the nuclei and cell bodies of more than 95% of the neurons undergo lysis, prior to the emergence of the adult from the pupa. This can be used in neural regeneration study.
- Structure of compound eyes of microinsects can be used in nano-optics.
- Two families of microinsects that have members which can be used as biological control agents are Mymaridae and Trichogrammatidae.

Conclusion

Gorodkov (1984) set the threshold of miniaturization (pumilization) at about 1 mm and suggested that overcoming this limit should be accompanied by dramatic simplification. But microinsects go below this threshold without much simplification, and even display a number of novel structures.

Future prospects

Miniaturization is more than a principal trend in insect evolution. It is also an important field of modern engineering. The data that have been obtained and patterns that have been revealed about the structure of microinsects can be used in microbotics, nano-optics, and modeling of neural networks and sensory systems.

Easy Indoor Plants for Every Home

GreenThumb

Easy care plants for home in the middle of a busy life is what everyone is looking for. There are a range of plants you can grow in yourfavorite place without spending a lot of time for their maintenance. For anyone who wants to nurture the plants, it is never too late to own your garden. As of 2024, more than half of the human population resides in urban areas. So, it

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Dracaena

is certain that by 2050, most of the people will be living in cities. To keep up with the exposure to greenery several attempts has been made in urban areas. For instance, different types of techniques like vertical farming, hydroponics, rooftop garden, backyard garden etc. are being tried.This helps to maintain greenery in spite of barrenness of tall buildings. Pollution from chemicals is reduced to an extent. Above all, dust and noise of cities could be reduced considerably by trees and plants. As many researchers have pointed out the ability of plants to reduce stress and improve productivity in workplace, cultivating plants have become a practice in many offices and institutions. With people giving importance to mental health, gardening has found its way in easing people's minds. It is of course some sort of exercise with respect to physical health. Even though house plants or the concept was present from ancient times, it has created a revolution in the past decade by living even the dimmest corners of rooms of homes, offices, malls and public places. All of us might have seen different indoor plants kept in the center of a table or balcony or in the corner of a room. This gives a cozy feel to the indoor area and creates the perfect space for reading a book or relaxing in your own way.

Community garden is one such activity which engages people living in urban areas who wants to make use of their

Snake plant

gardening skills as well as learn new things. This brings a group of people together which makes them feel less isolated and brings a sense of togetherness. In the middle of hectic city life, community garden gives a lushness to the environment. And there are people who take it as a full-time job to grow plants because of the increasing demand. Different kinds of plants are bought in bulk for beautification purposes. Both native plants and exotic flora are used for gardening purposes. Plants if produced on a large scale is a profitable business. There are tons of people who take up this business because of the rise in demand globally for indoor plants, ornamental plants etc. Now a days, landscape and designing by incorporating different plants and trees have become an essential part of pavements, roads and buildings to incorporate greenery in cities as well as in towns. All these kinds of vegetation help to preserve the biodiversity, which is certainly essential for the equilibrium of nature. And there are airport gardens inside airports of cities, apart from the elegance it provides, this has constructive effects on mental health of people and also a person can enjoy their layover by spending time in the garden terminal.

Green Spaces in Indoors

Pandemic like Covid made many individuals to realize their taste towards gardening.

Lucky bamboo

People started cultivating plants in their homes. For a period of time, plastic plants were popular for decorating spaces. People have started realizing the benefits of real plants and replaced the fake ones. Gardening has become the latest obsession. When gardening was not possible in an outdoor setting, people started growing plants indoors. It is good to see that many people are so enthusiastic to cultivate plants which clearly implies the human tendency to connect with nature and plants. Whether it may be balcony or bathroom, a plant was carefully chosen for decorating a particular spot in many households. Distinct shapes and structure of leaves of indoor plants influence the interior. It avoids the blandness of solid colors of rooms. With indoor plants we could feel pristine nature inside our personal space. To enhance the beauty of walls, plants can be grown by trellis system helps to maintain greenery very conveniently in homes. For those who wish to spend some time away from screen, this could be the perfect hobby and who cannot afford a pet, taking care of indoor plants could be an option.

Aglaonema/ Chinese evergreen

Dieffenbachia/ Dumb canes

Indoor plants are definitely loyal because regardless of the fact that it has been planted away from its natural setting, it never disappoints us. They grow well within the limited space when it is taken care properly. People who are allergic to pollens does not have to step back because a range of indoor plants does not produce pollen.

We just need to understand our surroundings to decide which plant can grow efficiently in a place. Each plant has different tolerance to moisture, humidity, sunlight and temperature. If we tackle this, we could grow any plant in preferred place. As we now know that light in the form of sun is not necessarily required for every plant, LED lights can be sufficient for healthy growth and photosynthesis of many indoor plants.Shrubs, foliage plants and succulents are mainly used to decorate indoors. There are plants which need direct sunlight, indirect sunlight or sometimes only shade for their growth. There are plants which are easy to grow, require little care and there are others which are difficult to maintain. We know very well how the plants could fix the carbon dioxide in the atmosphere.Indoor air pollution caused by chemicals which are components in our household products can be removed with the help of plants. Pots with drainage holes are essential as any other plant. Potting mix is the best for inhouse plants. This retains enough moisture for the plants if watered regularly. Fertilizing the plants with N, P, K regularly helps the plant to grow well.There are some indoor plants which you can grow without your efforts

Monstera/
Swiss cheese plant

going in vain.This does not mean you do not care them at all because every plant requires a minimum care to sustain. We should water it, check for pests and clean the dust since it reduces the amount of light which the plant can receive.

Indoor Gardening Plants for Easy Maintenance

Dracaena *(Dracaena spp., Asparagaceae)*

It is very common plant grown in garden as well as indoor places. It does not need direct sunlight. Dracaena can be grown inside our house where it receives shade and indirect sunlight. There are different types of Dracaenas including solid

green and variegated foliage.

Snake plant *(Dracaena trifasciata,* Asparagaceae*)*

It can be grown easily in indoors. What is essential is to avoid over watering your snake plant so that it won't rot. Check the soil for moisture content before regular watering. You need to water the snake plant if the soil feels dry. Damp soil has enough moisture to keep the plant alive. Drooping of leaves can be symptom of lack of watering. If the plant is too thirsty it can also show brown leaf tips.

Lucky bamboo *(Dracaena sanderiana,* Asparagaceae*)*

It is frequently seen in many homes for various reasons. It can be grown in soil or water. We have to change the water once a week to avoid occurrence of algae. It can grow in shade or indirect sunlight. You could keep it inside a ceramic pot for an attractive look.

Aglaonema/Chinese evergreen *(Aglaonema spp.,* Araceae*)*

Another foliage plant suitable to grow in shade without direct sunlight. Leaves of different Aglaonema are white and green colored or pink and green colored, which looks perfect when kept a little away from window sill. The direct sunlight leads to scorching of leaves. Good drainage of soil is required. This plant can be prone to root rot if it's over watered. So, water it accordingly. Thorough watering can be given once or twice a week.

Dieffenbachia/Dumb canes *(Dieffenbachia spp.,* Araceae*)*

Beautiful foliage plant with variegated leaves containing white, yellow and green colors. This genus usually consists of large leaves. This plant prefers light conditions but not direct sunlight. Light coming through a window sill is more than enough for the healthy growth of Dieffenbachia.We can grow dumb canes indoors with caution because the plant is highly poisonous if ingested. It can damage our mouth, tongue and throat causing inflammation due to the presence of calcium oxalate crystals in the sap. The sap can also cause eye irritation,

Pothos plant

inflammation and allergic reaction of the skin. This should not stop us from growing the plant because dumb canes are beneficial for the environment and air quality just like any other indoor plant. Water the plants liberally to keep the soil moist and avoid overwatering.

Monstera/Swiss cheese plant *(Monstera deliciosa, Araceae)*

It is abeginner friendly house plant with strong aerial roots and stem. Monstera tolerates medium sunlight and can grow easily inside and outside our home. It is the perfect plant for decorating indoors such as a corner of our room with enough sunlight or on our study table so that we could

keep track of its water and light requirements. Monsteras love moisture because of its tropical nature so we should not forget watering it. The large leaves of Monstera have to be wiped and cleaned to let enough sunlight for photosynthesis and to keep away from pests. Staking can be done to allow them to climb on it.

Pothos *(Epipremnumaureum, Araceae)*

Tropical vine which can be easily grown near a windowsill or any place with indirect sunlight. Direct sunlight can scorch the leaves. You can hang it on basket or use it to decorate by keeping near our bookshelf. Perfect fitting for offices, it can be grown even without too much care. The leaves can be wiped occasionally to avoid pests even though there will be less pest infestation. Variegated leaves of pothosareattractive and perfect for decorating indoors.

Syngonium/Arrowhead plant *(Syngonium podophyllum, Araceae)*

It comprises of different types according to the leaf shades, which ranges fromdark green, variegated topink. Certain types of syngoniumhave small leaves and others have larger leaves.The plant prefers indirect sunlight. We could keep it outdoors or indoors near a window. It can grow vigorouslywhich can be pruned to maintain the shape. Watering of arrowhead plant can be done regularly. It is important to note that we should allow the soil

to become a little dry between waterings which can keep the plant healthy without rot issues.

Aralia *(Aralia spp.,* Araliaceae)

It is an evergreen shrub frequently grown as indoor and outdoor places. Variegated white aralia are often used as an indoor plant. It is easy to maintain and has beautiful lacy leaves.Since it is a tropical foliage plant, it requires regular watering to maintain humid environment. We should check for moisture in soil after each watering.Indirect sunlight is enough to keep the

Zanzibar Gemor ZZ plant

plant healthy. Extreme light can damage the plant. Prune aralias to keep up good shape because some can get taller so easily.

Zanzibar Gemor ZZ plant

(Zamioculcaszamiifolia, Araceae*)*

Became popular in the recent years because of its striking pattern of pinnately compound leaves. The plant has glossy leaves and sturdy stems that it almost looks like a faux plant. Different colored ZZ plants are present, green and black being the common ones.It is very hard to kill this plant unless you do too much watering.ZZ plant can be watered once in two weeks after establishment, by checking the moisture in the soil. It does not need so much light that it can tolerate a little dark condition.Therefore, it should be kept away from windows to avoid direct sunlight.

China doll plant *(Radermach erasinica,*Bignoniaceae*)*

Popular plant due to its smooth glossy leaves and ability to grow indoors with moderate care. It can be kept in indirect sun with bright light for good growth. We can trim China doll at the tips once in a while for lateral branches to grow, thus giving a bushy look. It is a shrub with abundant leaves,which is beneficial for the surroundings. Watering should be done regularly by checking the moisture status of soil.

There are diverse types of indoor plants. Different kinds of plants are suited to distinct environmental conditions. Indoor plants mentioned here are relatively low maintenance yet beautiful and beneficial for indoors. All these plants are affordable and less expensive than many other plants in the market. So,anyone who is fond of indoor gardening but not yet had the opportunity to start your own indoor garden can try with these plants inside your home. There is nothing more rewarding than witnessing your plant grow healthy even in the middle of frantic life.

China doll plant

The World of Ornamental Bromeliads
A Burst of Tropical Beauty

Ornamental bromeliads are a vibrant and diverse group of plants that have become increasingly popular in-home gardens and interior landscapes. These plants are natives of Tropical America and are characterized by their rosettes

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Aechmea

Guzmania

of leaves and central flower spikes.They belong to Bromeliaceae family which includes over 3,000 species. These plants are available in a wide range of colors, from deep reds and vibrant yellows to cool blues and purples, making them a stunning addition to any plant collection. Bromeliads not only add visual interest but also bring a touch of the tropics to any setting.

Care and management

Bromeliads are generally easy to care for, making them ideal for both novice and experienced gardeners. Most bromeliads thrive in bright, indirect light. Too much direct sunlight can scorch their leaves, while too little light can cause them to lose their vibrant colors. They can be watered by filling the central cup, and make sure to empty and refill it regularly to prevent stagnation. For soil-grown bromeliads, the soil should be kept lightly moist but not soggy. Regular misting and placing the plants on a humidity tray can help maintain the necessary humidity levels

Tillandsia

since they usually prefer a humid environment. These tropical plants prefer temperatures between 15-27°C and thus, should be protected from cold drafts and sudden temperature changes.

Unlike many other plants, bromeliads do not thrive in regular garden soil. They could be grown in a mix of orchid bark, perlite, and peat moss or coconut coir. This combination ensures good drainage while retaining enough moisture. Epiphytic bromeliads, such as Tillandsia (air plants), can be mounted on wood, cork, or other porous surfaces. These plants do not need soil and should be secured with a non-damaging material like fishing line or a soft wire. For terrestrial bromeliads, a well-draining potting mix

Vriesea

with added sand or perlite is ideal.

Bromeliads can be propagated through several methods, with the most common being the separation of offsets, also known as pups that grow at the base of the mother plant. Pups can be removed once they are at least one-third to one-half the size of the mother plant by gently twisting or cutting with some roots attached. Plants can be propagated using seeds also. Seeds should be provided with a warm, humid environment and indirect light for germination.

Some bromeliads, especially those which form clumps, can be propagated by divisions by removing the plant from its pot and gently separating the clumps, ensuring each division has roots attached so that it can further be replanted.

Popular genera in Ornamental Bromeliads

Aechmea: Aechmea is one of the most well-known genera of bromeliads. These plants are characterized by their broad, arching leaves and tall, colorful flower spikes. The most famous species, *Aechmea fasciata*, features silver-green leaves with a pink flower spike and blue flowers.

Neoregelia: They are admired for their rosette-shaped foliage, which often displays vibrant colors and patterns. Unlike many other bromeliads, Neoregelias produce small, inconspicuous flowers in the center of the rosette, with the main attraction being the colorful leaves. These plants thrive in bright, indirect light and high humidity. They require regular misting and should be watered in the central cup formed by the leaves.

Guzmania: They are popular for their long-lasting, bright flower bracts that come in shades of red, orange, yellow, and pink. The flowers rise from the center of the rosette and can last for several months, making them a favorite for indoor displays. They should be kept in a well-ventilated area to prevent rot.

Tillandsia (Air Plants): Tillandsias, commonly known as air plants, are unique among bromeliads because they do not require soil to grow. They absorb water and nutrients through their leaves and can be displayed in a variety of creative ways, such as mounted on driftwood or placed in glass terrariums.Air plants need bright, indirect light and should be soaked in water for a few hours every week. They also benefit from regular misting.


Bilbergia

Vriesea: Vriesea plants are known for their striking, sword-like flower spikes that come in an array of colors. The leaves are typically green and can be variegated or patterned. One of the most popular species, *Vriesea splendens*, is often known as the flaming sword plant.

Bilbergia: Bilbegia are known for their rosette-forming, spiny-edged leaves and striking tubular flowers, which come in vibrant colors such as pink, red, blue, or purple. These plants can be epiphytic or terrestrial, thriving in a variety of environments. They prefer bright, indirect light, moderate watering, and well-draining soil. Popular species include Billbergia nutans ("Queen's Tears") and Billbergia pyramidalis. Bilbergias are valued for their unique appearance and ease of care, making them popular in both indoor and outdoor gardens.

Aerial Reforestation by Seed Bombing

Trees are essential to the ecosystem's ability to remain balanced. But, modernisation, urbanisation, population expansion, etc., have led to the rapid decline of the earth's green cover. By multiplying seed balls, degraded and fragmented areas can be made greener at a low cost. By encapsulating the seeds in appropriate substrates and fostering a congenial microenvironment that enhances viability, vigour and germination. They can quickly cover large areas, especially in remote and challenging terrains, increasing the essential ecosystems can be successfully restored and revitalized by carefully choosing the right plant species. In order to ensure optimal seed distribution patterns and maximize ecosystem recovery, advances in aerial delivery technology, such as the utilization of drones and aircraft.

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Seed Bombing

The term "seed bombing" refers to the novel method of aerial seeding used in ecological restoration to get around the challenges of large-scale vegetation regeneration in a range of environments.

Meterial Required

Clay

Compost

Seed

A seed bomb is a tiny ball that is often composed of seeds, clay, and compost. The compost and clay act as a carrier for the seeds so they can be launched over walls or fences and into inaccessible areas such as wasteland or railways. The clay bonds the seed bomb, giving it enough strength to not shatter when it strikes the ground, while the compost provides nutrition for the seeds to germinate and become strong. It is applied in delicate habitats to help with reforestation and revegetation.

Methodology

To maximize germination and seedling establishment, the technique of seed bombing employs a methodical strategy to ensure that seeds are spread aerially in an efficient and effective manner.

Seed selection: The choice of native seed species that coexist with the intended ecosystem is carefully considered..

Seed processing: The collected seeds are sorted, cleaned, and quality-tested to eliminate any pollutants, dirt, or damaged seeds. Utilize just thriving and healthy seeds.


1 Mixing
2 Forming
3 Planting

Seed treatment:
Pregermination treatments like scarification or stratification are applied to seeds in order to increase germination rates and break seed dormancy.

Seed encapsulation: Clay, compost, and potentially other organic materials are used to create a barrier around the cleaned seeds. The coating acts as a barrier against external elements and retains moisture, protecting the seeds during distribution and storage.

Seed bomb preparation: The encapsulated seeds are mixed with other components like organic fertilizers, mycorrhizal inoculants, or water-absorbing polymers to improve soil conditions and boost seedling vigor. These supplements are capable of providing essential nutrients and encouraging beneficial microbial interactions. Seed bomb drying and curing: In order to prevent mold or fungal growth, the newly created seed bombs undergo a drying and curing procedure to assure stability and longevity.

Seed bomb testing: In order to ascertain the viability of the seeds and ensure their quality, seed bombs are often subjected to germination tests before being widely distributed.

Aerial deployment planning: The target restoration area is extensively analyzed and plotted to identify the optimal locations for seed bombing. Topography, vegetation cover, soil quality, and accessibility are all taken into account. The most efficient flight paths and the locations needing concentrated seed dispersal are determined during this planning phase.

Aerial deployment execution: Helicopters, drones, or specialized aircraft equipped with seed dispersion equipment are employed for airborne deployment. To cover uniform specified areas, trained operators drop seed bombs at predetermined intervals.

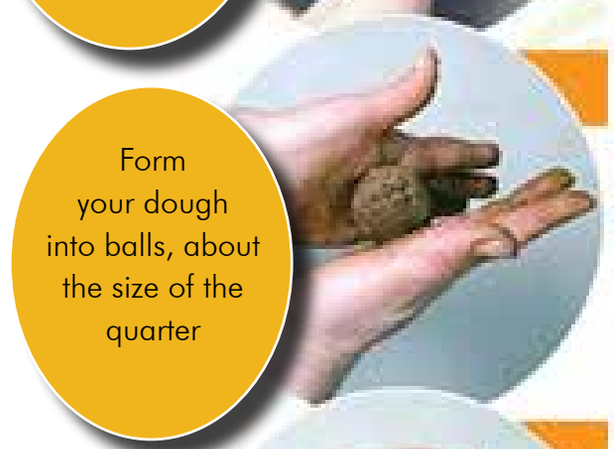
Benefits

- Increase green space
- Effective for inaccessible places
- Safe method
- Sustainable method
- Increase Tourism
- Help to curb climate change

Drones are able to easily access locations that are inaccessible to people. Drones are increasingly being seen as a feasible option for seed bombardment when the world needs to ensure efficient coverage of a broad territory in a prompt manner. Modern drones not only make it easier for people to restore forests, but they also increase crop yields by aerial seeding. Aerial reforestation is the most efficient method of treatment when wet soil and undulating land render other methods ineffective. Tropical forests stand to gain the most from this planting technique since they are more effective carbon sinks and support a wider range of plant and animal species.


In a bowl, mix one part of clay with four to five parts of compost


Stir while slowly mixing with water until you have dough


Form your dough into balls, about the size of the quarter


Press a hole into each ball and place 3 or 4 seeds into it. Close up the hole


Lay the balls on plates and keep it for air dry


When spring arrives, scatter the seed bombs on open ground. The shell will protect the seeds from birds while providing needed moisture for them to sprout

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Flavouring and Healing roots- An in-depth look into Decalepis hamiltonii and Hemidesmus indicus

Decalepis hamiltonii and *Hemidesmus indicus* are the valuable medicinal and aromaticplants which possess several therapeutic properties from their flavouring roots which makes them valuable and vulnerable as well. Due to deforestation, urbanisation and over exploitation, these crops make them to be scarcely available naturally in their habitats. In this regard due awareness of conservation of these flavoring root plants is need of the hour which emphasise the conservation, potential for developing standard agrotechnology, problems and their medicinal values. In this article we are focussing to explain the botanical features, systematics, status of availability, therapeutic properties and value-added products of these roots.

Introduction

Decalepis hamiltonii and *Hemidesmus indicus* are endemic, endangered medicinal

	Hemidesmus indicus	*Decalepis hamiltonii*
Kingdom	Plantae	Plantae
Phylum	Tracheophyta	Streptophyta
Class	Magnoliopsida	Magnoliopsida
Sub class	Magnoliidae	Magnoliidae
Order	Gentianales	Gentianales
Family	Asclepiadaceae	Apocynaceae
Genus	Hemidesmus	Decalepis
Species	Indicus	hamiltonii

and aromatic plants that grow mainly in dry deciduous forests of India. These plants are perennial woody climbing shrubs, valued for its aromatic tuberous roots and are generally used as a health drink. Where, *Decalepishamiltonii* is also called as swallow root/Indian Sarsaparilla which is very popular in Rayalaseema region of Andhra Pradesh as Nannari Sharbat and are well known for its nutraceutical and medicinal values. While *Hemidesmusindicus* is well distributed across Indian peninsular also known as "Anantmool" which is an essential ingredient in preparation of medicinal formulations in different systems (Ayurveda, Siddha, and Unani).

These both species has been traditionally used in various systems of Indian medicines. Roots of these plants are being used in Unani, Siddha and Folk medicine as well as Ayurveda.

Botany

Decalepis hamiltonii Wight &Arn. is a climbing shrub belonging to the Asclepiadaceae family, this plant thrives in dry deciduous forests and scrub jungles, often found on hills up to 1100 meters, among rocks and stream banks. The plant exudes a milky latex throughout its structure and produces multiple roots from its rootstock, with mature plants yielding significant quantities of roots. Its leaves are obovate-elliptic or circular, with blunt tips and membranous texture, and the plant features small, white flowers arranged in trichotomously branched cymes. Flowering and fruiting occur from May to December, with cylindrical oblong seedpods that are woody when dry, containing many egg-shaped seeds with long silky hairs. Swallow-Root underscores the need for conservation efforts to preserve its natural habitat and ensure its survival.

Hemidesmus indicus R.Br.,(syn. Periploca indica)belonging to the Apocynaceae familyis a slender, twining, and fast-growing shrub that can either lie on the ground or stand semi-erect. It has a woody and aromatic root system. The stems are many, thin, and have milky latex, with thickened nodes. The lower leaves are narrow and sometimes have white stripes, while the upper leaves are broader and dark green without stripes. Flowers are small and grow in clusters at the leaf axils, have a unique appearance; green on the outside and purplish to yellowish-orange on the inside. They have fleshy petals, five-lobed calyx, a tubular corolla about 5–6 mm long, five stamens, and a pistil made up of two carpels. Flowering happens from October to January.The fruit consists of two slender, gradually narrowing pods (follicles) that are 10–15 cm long and start to appear from February onwards. The seeds inside are numerous, black, flattened, and have tiny silvery white hairs.

Systematics and distribution

Decalepis hamiltonii and *Hemidesmus indicusare* the most potential medicinal and aromatic root yielding plants. *Hemidesmus indicusis* common in India and the species is also well distributed across tropical Asian countries like Pakistan, Iran, Malaysia, Indonesia, Sri Lanka, Bangladesh and Moluccas. In India, *H. indicus* will be found mostly throughout India from Northern India to North Eastern India and in Southern peninsular tropical moist environments. *Decalepis hamiltoniiis* endemic to Peninsular India, particularly distributed across South India in various districts of Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu. These plants contain various phytoconstituents like flavonoids, tannins, glycoside, sterols, and volatile oil.

Therapeutic properties

Roots of *D.hamiltonii*, contain 2-hydroxy-

4-methoxybenzaldehyde, an isomer of vanillin. Initially bitter and then sweet, these aromatic roots have a lingering aftertaste and smell reminiscent of *Vanilla planifolia*. Extensively used for their flavoring properties, they serve as an appetizer, blood purifier, and preservative. All parts of *H. indicus* contains various secondary metabolites such as saponins, glycosides, flavonoids and triterpenoids. Where roots contain mainly 2-hydroxy-4-methoxy benzaldehyde, 4-hydroxy-3-methoxy benzaldehyde and hexatriacontane acid. Stems contain Hemidine, hindicusine, desinine, di-Oacetylhindicusine, indicineindi-cusin and denicunine.

Numerous systematic studies on both the species have suggested these properties and hence, there has been an increasing awareness among the masses on its health benefits. *D. hamiltonii* is a multipurpose plant and tubers of this have been identified as a traditional health drink owing to its nutritional value, besides its antioxidant, antimicrobial, antipyretic, antiulcer, insecticidal, chemo protective and neuroprotective activities. These stimulate appetite, relieve flatulence, skin diseases and as a general health drink.The roots exhibit bio insecticidal activity against storage pests and can act as a fish poison, remaining stable over long periods without microbial contamination. Locally in Andhra Pradesh, the Yanadi people prepare a drink called nannari or sugandhapala from the roots, often mixed with *Hemidesmus indicus* for a cooling effect. This drink, resembling Coca-Cola in appearance and having a vanilla smell, serves as a health tonic that cools the system, stimulates appetite, and acts as a blood purifier. Additionally, the roots

are used to make chutney and pickle, which help with indigestion, constipation, and gas troubles.

H. indicus, commonly utilized in traditional medicine, is renowned for its versatility in treating a variety of ailments. It has been employed for conditions such as diabetes, leprosy, skin and urinary diseases, sexually transmitted infections including syphilis, and for mitigating the effects of snakebites and scorpion stings. Additionally, it is used to alleviate respiratory disorders like dyspnoea, bronchitis, and cough, as well as inflammation, rheumatism, and pain. The plant is also beneficial for gastrointestinal issues such as abdominal colic, dysentery, diarrhoea, anorexia, and pyrosis. It has applications in managing menorrhagia and oligospermia and serves as a blood purifier, appetite stimulant, and overall health promoter, often valued for its cooling properties. Furthermore, *H. indicus* has roles in treating fever, cancer, and headache, highlighting its broad therapeutic potential.

Value added products

Several value-added products are being prepared from the root extracts of Hemidesmus indicus and Decalepis hamiltonii, few products are explained here mainly, Root extracts of H. indicus used to prepare a popular South Indian summer beverage called "Nannari" or Nannari sherbet. This drink's popularity waned with the rise of international soft drinks like Cola and Pepsi. However, there is a lot of scope to develop carbonated soft drinks from these roots, featuring a more appealing natural flavour and taste. These herbal drinks will offer a healthier alternative to the chemical-laden soft drinks such as Coca cola, Pepsi, Thumbs up etc., that currently dominating the market, which will potentially help to combat issues related to obesity and ill-health.

Additionally, these roots are used to make a traditional pickle known as 'Mahani pickle,' which is yet to achieve widespread recognition as a nutraceutical. Another innovative use of the root extract is in 'nannari milk,' a nutritious beverage created by mixing nannari syrup with milk and sweetening it with jaggery or honey. This could become a popular drink for both children and adults in the future.

However, due to indiscriminate exploitation of these plants, lower rate of seed germination ecological and climatic conditions leads to the endangering these species in the natural ecosystem. Hence, there is an urgent need for conservation of this species for the present and forthcoming generations. there is lot of scope for the systematic research in future to standardise the commercial cultivation of these endangered and endemic plants which are so valuable to the human kind which will help in its conservation but would also help in promoting the cultivation of this valuable genetic resource.

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Commercial Dryers for Spice Processing

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Various conventional and non-conventional technologies are used in food industries for spice drying. Most of the spices should be dried under temperatures of 45-60°C to achieve final moisture content in range of 6-12% for proper storage (Jayashree and Anees, 2020). High temperature drying is not recommended for spices as it causes loss of volatile components and nutrients (Jayashree et al., 2014). The most primitive method is the open-air sun drying, wherein the fresh spices in thin layers are spread over concrete, mat or trayand exposed to incoming solar irradiation along with convective wind power (Fig. 1).Though the method is highly economic, risk of damage by predators, product degradation due to uncontrolled drying temperatures, climatic variations and non-uniform drying are the various drawbacks associated (Arunsandeep et al., 2018). Hence, various designs of solar based drying systems have been evolved that utilizes solar energy to maintain controlled drying conditions for heat sensitive spice products. The article discusses the different types of dryers available for commercial

Fig. 1 Traditional sun drying of chilli

Fig. 2 a) Solar tunnel dryer installed at ICAR – IISR, Kozhikode b) Drying of mace in solar tunnel dryer

drying of spices.

a. Solar tunnel dryer

Solar tunnel dryer comprises of a drying chamber (semi-cylindrical in shape), metallic frame, UV stabilized polyethylene sheet, inlet and exit ports for air circulation. The cement plastered bottom of theunitiscoated with black colour paint to harness maximum solar energy. The trays with tray holders are placed inside the dryer for spreading spice products for drying. These are low-cost, energy-efficient dryers usually employed for bulk drying spices. ICAR-IISR has developed and installed a 500 kg capacity solar tunnel drier with biomass back-up for efficient drying of spices like black pepper, turmeric, ginger, chilli and other spices (Fig. 2). This is a stand-alone system that uses PV panels to run the electrical devices like fans and controllers inside the drying unit. Moisture contents of rhizomatous spices such as ginger and turmeric are reduced from 75% to13% under solar tunnel drying system in 10 – 12 days. Temperature inside the dryer varies in range of 55 – 60°C during peak sunshine hours.

b. Biomass dryer

A typicalbiomass dryer is made up of a combustion chamber, inlet for drying air, drying chamber, chimney and blower. Biomass is a predominant form of renewable energy. Combustion of biomass takes place in the furnace of the dryer and heat energy is carried away by the drying air in to the drying chamber. The heated air removes moisture from the wet samples and is recirculated for better energy efficiency. Temperature of the drying chamber can be set in the range of 45 – 60°C, depending on the spice to be dried. Any drop from set value of temperature may be reflected from the incomplete

Table 1 Safe moisture content limit for dried

Spice	Maximum final moisture content % (wet basis)
Mace	6 – 7%
Nutmeg, cloves	8 – 9 %
Coriander	8 – 9 %
Cinnamon	9 – 11%
Cardamon	11 – 13%
Pepper, pimento, chillies, ginger, turmeric	11 – 13%

Fig. 3 Biomass drying of cardamom (Source: Greenguard dryers, Idukki)

combustion of biomass. Hence, proper monitoring of the drying process is required. This type of drying systems can be adopted for cardamom where shade drying in preferred to retain green colour. Nutmeg, mace, clove, chilli, garlic and pepper are also dried using these dryers (Fig. 3).

c. Tray dryer

A tray dryer is the most typical convective drying system found in food industry. It consists of a series of trays arranged vertically in one or more columns, stainless steel trays, blower, exhaust, heating coil and other controls. The blower sucks the ambient air which is heated by the heater coil to desired temperatures and circulated through the drying chamber. Moisture laden air escapes through the exhaust. Power requirement for the heating coil and blower is determined based on the capacity and heat load. The trays should be perforated with adequate spacing between them that facilitate easy flow of hot air. Drying time depends on the thickness of the product and final moisture content required. Photograph of tray dryer with a capacity of 40 – 50 kg installed at ICAR – IISR, Kozhikode is shown in Fig. 4. Safe final moisture content of some of the spices are shown in Table 1:

d. Rotary dryer

A rotary dryer consists of a heating source, rotating chamber, blower, exhaust, trays for keeping the product and other controls. Uniformity in drying is achieved by the rotary action of the trays. Heating source can be heater coil or LPG firing system. ICAR-IISR has installed a rotary dryer with a capacity of drying 50-100 kg of spices. The power required to

Fig. 4 Tray dryer for spices installed at ICAR – IISR, Kozhikode

operate the unit is 0.37 kW.

e. Spray dryer

Spray drying is the process of converting solutions, suspensions or paste into dried powder by feeding into a hot drying medium. It involves atomization of liquid feed into spray droplet that contacts with hot air in the drying chamber. The atomizer breaks the bulk liquid into small sized droplets forming a spray, thereby imparting maximum surface area for evaporation. Commonly used atomizers in spray dryers are rotary, pressure and pneumatic nozzle types. Photograph of spray dryer installed at ICAR – IISR, Kozhikode and spray dried ginger-lime juice powder is shown in Fig. 5 and Fig. 6 respectively. The installed dryer has an evaporation rate of 3 – 5 liters of water per hour.

In spice processing industry spray dryers are used in microencapsulation of spice extractives, essential oils and oleoresins to produce tertiary processed products. Ostroschi et al. (2018) produced cinnamon proanthocyanidin from cinnamon extract using spray drying technology. The process reduced astringency and improved stability of the cinnamon proanthocyanidin which has important biological properties. Simon et al. (2016) reported on the potential of spray dried ginger extract as a novel food ingredient using

Fig. 5 Spray dryer installed at ICAR – IISR, Kozhikode

maltodextrin or gum arabica as wall materials. Qin et al. (2014) studied microencapsulation of star anise oleoresin using maltodextrin and soy protein as the wall materials. Authors reported oleoresin level of 5%, maltodextrin level of 25%, soy protein level of 7.5% and inlet air temperature of 180 °C as the optimized conditions for highest yield of powder.

f. Vacuum dryer

Vacuum drying is a process by which foods are dried under lower operating pressures that in turn reduces the temperature required for drying. It consumes lesser time as compared to convective drying due to effective hydraulic conductivity of products under vacuum. As the drying process is achieved under reduced operating temperatures, it is significantly applied for drying of heat sensitive products. Microstructure of vacuum dried foods generally have higher porosity enabling better rehydration and reconstitution properties. Vacuum drying improved the colour and texture of mace, ginger and turmeric as compared to mechanical dryers. Photograph of vacuum tray dryer of capacity 20 – 30 kg installed at ICAR – IISR are shown in Fig. 7.

Fig. 6 Spray dried ginger-lime juice powder and reconstituted juice

g. Freeze dryer

Freeze drying or lyophilization preserves food by freezing followed by sublimation. Sublimation is the transition from solid to vapor phase without passing through the liquid phase. It involves cooling of food below its eutectic temperature, initially product solidifies completely, followed by drying under vacuum at lower temperature. Sublimation commences from outer part and progress inwards slowly and a pervious dried layer is formed simultaneously. Freeze drying provide high retention of sensory and nutritional characteristics of foods and offers extended shelf life when properly packed. The texture of freeze-dried foods

Fig. 7 a) Vacuum tray dryer installed at ICAR – IISR, Kozhikode b) Drying of mace in vacuum tray dryer

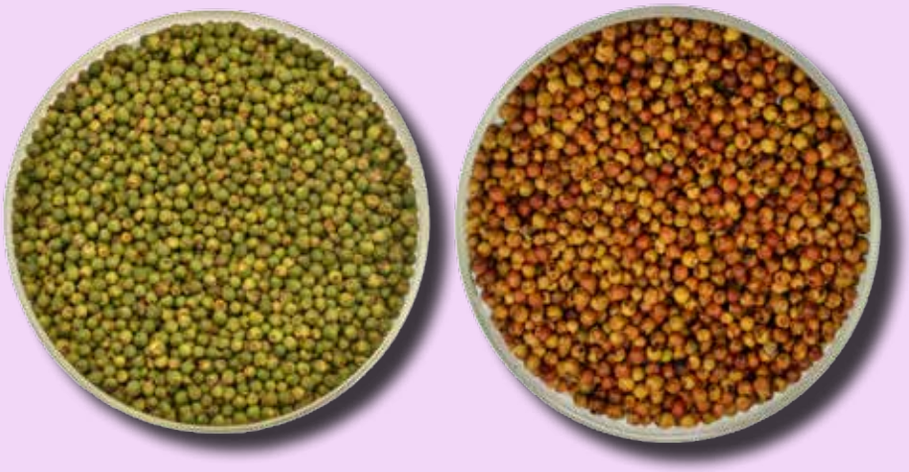

Fig. 8 a) Freeze dried green pepper
|b) Freeze dried red pepper

is superior with little shrinkage and case hardening. The porous cell structure of the products facilitates maximum rehydration. Freeze drying can be used in production of spice powders without losing its volatile components. Photographs of freeze-dried pepper products are shown in Fig. 8.

h. Infrareddryer

Infrared (IR) radiation belongs to electromagnetic spectrum with wavelengths varying in range of 0.78 μm – 1000 μm. Water molecules have

Fig. 9 a) Infrared dryer installed in ICAR – IISR, Kozhikode
b) Drying of turmeric slices in infrared dryer

four principal absorption bands at 3, 4.7, 6, and 15.3 μm. This wide IR absorption spectrum of water facilitates its application in food drying. IRinterferes with the vibrational state of molecules and causes rapid heating. Integration of infrared with microwave and vacuum obtained better quality for chilli and pepper with regard to colour, rehydration ability, shrinkage, and texture.Shorter processing time, uniformity in product temperature, lower thermal inertia, better drying efficiency and easiness of installation are some of the advantages of this system. Drying times for turmeric slices and mace were lesser in infrared dryer as compared to mechanical dryers. Photograph of infrared dryer and drying of turmeric slices in the infrared dryer installed at ICAR – IISR, Kozhikode is shown in Fig. 9. The capacity of the dryer is 8 – 10 kg.

i. Microwave dryer

Microwaves are non-ionizing electromagnetic radiation in the frequency range of 300 MHz - 300 GHz with a wavelength of 1 mm-1m. Heating by microwaves is achieved by dipole rotation and ionic polarization. For domestic and industrial applications, microwave frequency of 2450 MHz, is used wherein the electric field changes polarity 2.45 billion times a second, making the dipoles move with it. This results in friction and generate heat inside the food material. This is called dipole rotation. Ionic polarization refers to the migration of ions under the influence of electric field that results in generation of heat. The basic components of a microwave dryer are magnetron, wave guide and applicator (Alfiya et al., 2022).

Case hardening of dried products is reduced in microwave drying because of the moisture pumping effect. Combined microwave-hot air drying reduced drying time to an extend of 80–90 per cent as compared to conventional drying (Sharma and Prasad, 2001). Microwave drying was found to retain terpene concentration in ginger (Huang et al. 2012). Combined microwave and vacuum drying of exhibited better rehydration ratio and softer structure for ginger (Cui et al., 2003) and increased curcuminoid concentration and antioxidant activities for turmeric (Hirun et al., 2014).

Conclusion

The selection of drying systems for spice drying depends on the initial form of the raw materials to be dried, moisture content and final quality of the end products required. Drying of rhizomatous spices like ginger and turmeric are usually carried out in solar tunnel based drying systems. Whereas their slices can be dried in mechanical dryers. Biomass dryers are used for thick bed drying of spices such as large and small cardamom., clove, mace and chilli. Black pepper, mace, star anise are dried in solar based or mechanical drying systems. Cinnamon and nutmeg are dried at temperatures not exceeding 45 – 50 °C. Infrared drying of spices has emerged as an economic alternative to mechanical drying. Premium dried spices and their powders can be obtained by vacuum and freeze drying. Spray drying is recommended for the stabilization of bioactive compounds of spices. Proper selection of drying methods for spices results in obtaining dried products which are superior in colour, texture, flavour and overall acceptability.

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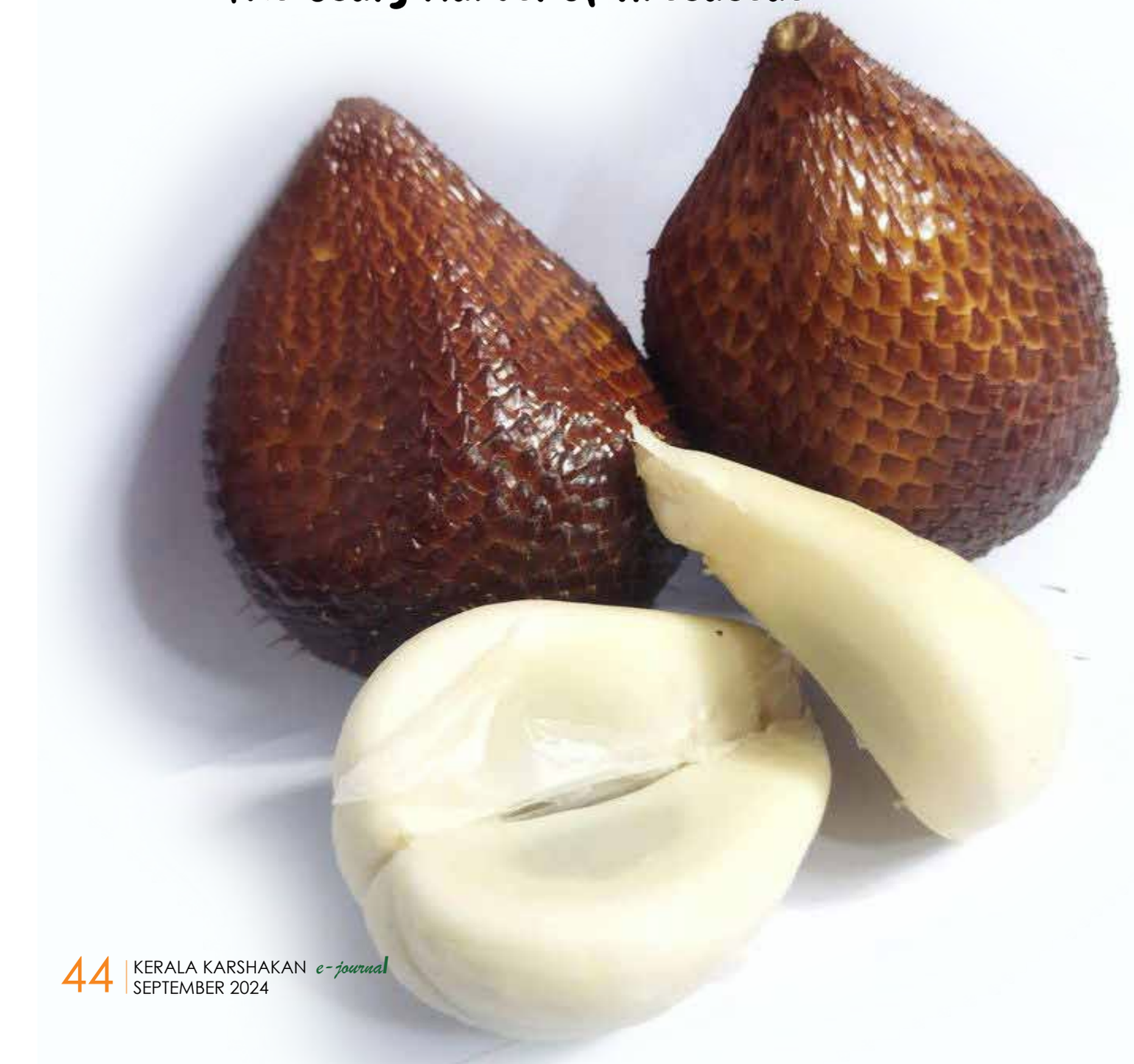
Snake fruit

The Scaly Marvel of Arecaceae

Introduction

Snake fruit (*Salacca zalacca*) is a species of palm tree belongs to family Arecaceae and is native to Java and Sumatra in Indonesia. The plant of this family can be found in tropical countries and are abundant in South East Asian countries like Indonesia, Malaysia, and Thailand.This fruit it is also called "The Future of Our



Health" and "The Superheroes of Functionality". Salak has various names, it is called 'pondoh' in Indonesia, 'rakam' in Thailand, 'salaka' or 'she pi guo zong' in China, and 'yingan' in Myanmar (Rangsiruji et al., 2006)

The fruit has also been introduced to countries of other regions including New Guinea, Philippines, Queensland and northern Territory of Australia, Ponape Island (Caroline Archipelago), China, Surinam, Spain, and Fiji. It is cultivated in other regions of Indonesia as a food crop.

Botanical description

Snake fruit is a very short-stemmed palm, with leaves up to 6 metres (20 ft) long. Each leaf has a 2metrelong petiole with spines up to 15 centimetres (5.9 in) long, and numerous leaflets. The fruits grow in clusters at the base of the palm, and are also known as snake fruit or snakeskin fruit due to the reddish-brown scaly skin. The upper surface of the leaflets is dark green and shiny, while lower surface is light green. Long, strong, grey to blackish spine clusters are distributed along the frond base at intervals of 3–5 cm. (Kueh, 2003)

The fruit, resembling a ripe fig in size and shape, has a crunchy and moist consistency

and it contains three pieces of seeds covered with white flesh. The edible pulp inside, often compared to large peeled garlic cloves in appearance, offers a unique flavor profile.

The palm fruits at about 3–4 years after planting. It is usually dioecious, although some have been found to be monoecious (e.g. Salak Bali) where they could self-pollinate. The inflorescence is an axillary compound spadix with a stalk: the female inflorescences are 20–30 cm long, and are composed of 1–3 spadices, 7–10 cm long; the male inflorescences are 50–100 cm long, consisting of 4–12 spadices, each measuring 7–15 cm × 0.7–2 cm. About 20% of the male palms are retained as pollinators, while the rest are removed. Assisted pollination is carried out to improve the fruit set. (Kueh, 2003)

Species

There are 21 species and four varieties of Salacca. There are three main species of salak grown commercially in Malaysia, which are *S. glaberescens*, *S. edulis* and *S. sumatrana*.*S.* glaberescens is known as local salak and there are nine clones being bred for planting while *S. edulis* and *S. sumatrana* are the two species of salak introduced from Indonesia. In Indonesia, the important commercial cultivars for domestic and export markets are *S. zalacca* with the synonim *S. edulis* and *S. sumatrana*. *S. zalacca* is subdivided into two varieties var. zalacca fromJava and var. amboinensis (Becc.) Mogea from Bali and Ambon.*S.* sumatrana is more commonly known as salak Padang Sidempuan (NorthSumatra) (Supapvanich *et al.,* 2011).

Composition and uses

Snake fruit contains various phytoconstituents and nutrients in abundance, comparably with other local fruits. The fruit contains sucrose (7.6 g/100 g), fructose (3.9 g/100 g), total sugar (17.4 g/100 g), soluble dietary fibre (0.3 g/100 g), insoluble dietary fibre (1.4 g/100 g), total dietary fibre (1.7 g/100 g), water (80 g/100 g), calories (77 kcal/100g), protein (0.7 g/100 g), ash (0.6 g/100 g) and fat (0.1 g/100 g).

The fruit of snake fruit is a source of natural sugars and dietary fibre. Besides, snake fruit pulp is reported to contain minerals and vitamins in abundance. The mineral content and vitamins that can be found in Salacca is phosphorous (1161 mg/kg), potassium (11.339 mg/kg), calcium (220 mg/kg), magnesium (607 mg/kg), sodium (231 mg/kg), iron (12.0 mg/kg), manganese (10.4 mg/kg), copper (3.36 mg/kg), zinc (10.4 mg/kg), boron (5.07 mg/kg), sulphur (5.07 mg/kg), ascorbic acid (400 mg/kg), carotene (5 mg/kg), thiamine (20 mg/kg), niacin (240 mg/kg), riboflavin (0.8 mg/kg) and folate (6 mg/kg) (Janick and Paull, 2008).

Snake fruit is a good source of carbohydrate and dietary fibre. The fruit pulp has been reported to possess high antioxidant capacity as compared to other exotic fruits. The pulps of snake fruit are mainly consumed either freshly or as juice. They are also processed into dried fruits, pickles, chips, canned in syrup as well as added as an ingredient in local food called rojak. Besides, the seed kernels of young fruits of pondoh (Indonesian salak) are edible. Apart from the fruit, the snake fruit palm bark of the petioles is also used for matting,while the leaflets are used for thatching (Aralas et al., 2009).

Varieties

There are some varieties of snake fruit such as Manonjaya, Bongkok, Banjarnegara, Condet, Pondoh, Bali, Enrengkang, and Sidempuan. Most of snake fruit have an astringent taste and are not sweet. Snake fruit var. Bongkok from Conggeang,

a sub district of Sumedang West Java, is more sour, bitter, stringent and not sweet than the other snake fruit.

Cultivation

Salak is typically propagated from seeds, but only 50% of the seedlings are female, and the fruit quality is inconsistent. Propagation through suckers is preferred to retain the characteristics of the mother palms. Splitting a 6–12 month old young palm into pieces containing leaf, pseudostem, and roots is one of the most effective techniques (Abu Bakar and Idris, 2006). These palms thrive in soil with a pH of 4.7 to 7.5 and prefer shade during their early growth. In commercial orchards, they are often intercropped with trees like coconut and durian for shading. The palms begin flowering at 3-4 years old and can remain productive for over 50 years, yielding 5–15 t/ha annually. While they can flower up to four times a year, fruiting occurs only in April and October.

Once the plants reach a height of 60–70 cm after 5–7 months, they are transferred to the field at the onset of the rainy season. The planting pits are typically 40 × 40 × 40 cm, with spacing between plants ranging from 1.5 × 3 m to 2 × 2 m. Regular pruning and weeding every two months are essential for maintaining aeration, optimizing light, and stimulating blooming. Thinning is done once or twice a year to remove abnormal or damaged fruits, ensuring about 20–25 fruits per bunch for optimal quality. Irrigation primarily relies on rainwater, with additional watering during the dry season, particularly after pruning or during fruit development. Minimal irrigation is applied during flowering and close to harvest to prevent root and fruit rot. In commercial plantations, hand pollination is performed by manually transferring pollen from male to female flowers. Successful pollination is indicated by the hardening of the flower, while unsuccessful flowers remain soft and are removed (Mazumdaret al., 2019).

Harvesting

Fruit maturity is primarily assessed by size, color (blackish brown for the Pondoh variety), aroma and the loss of tiny spines from the fruit skin.Manual harvesting is conducted when the fruits reach 70–80% maturity. For the export market, fruits of optimum quality are selected through individual inspection for damage, then placed into plastic crates and transported to the collection house for initial sorting. The remaining fruits are placed into bamboo baskets for the local market. In addition to being sold as fresh fruit, snake fruit is also used locally for making pickles and brewing wine with sugars and yeast.

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