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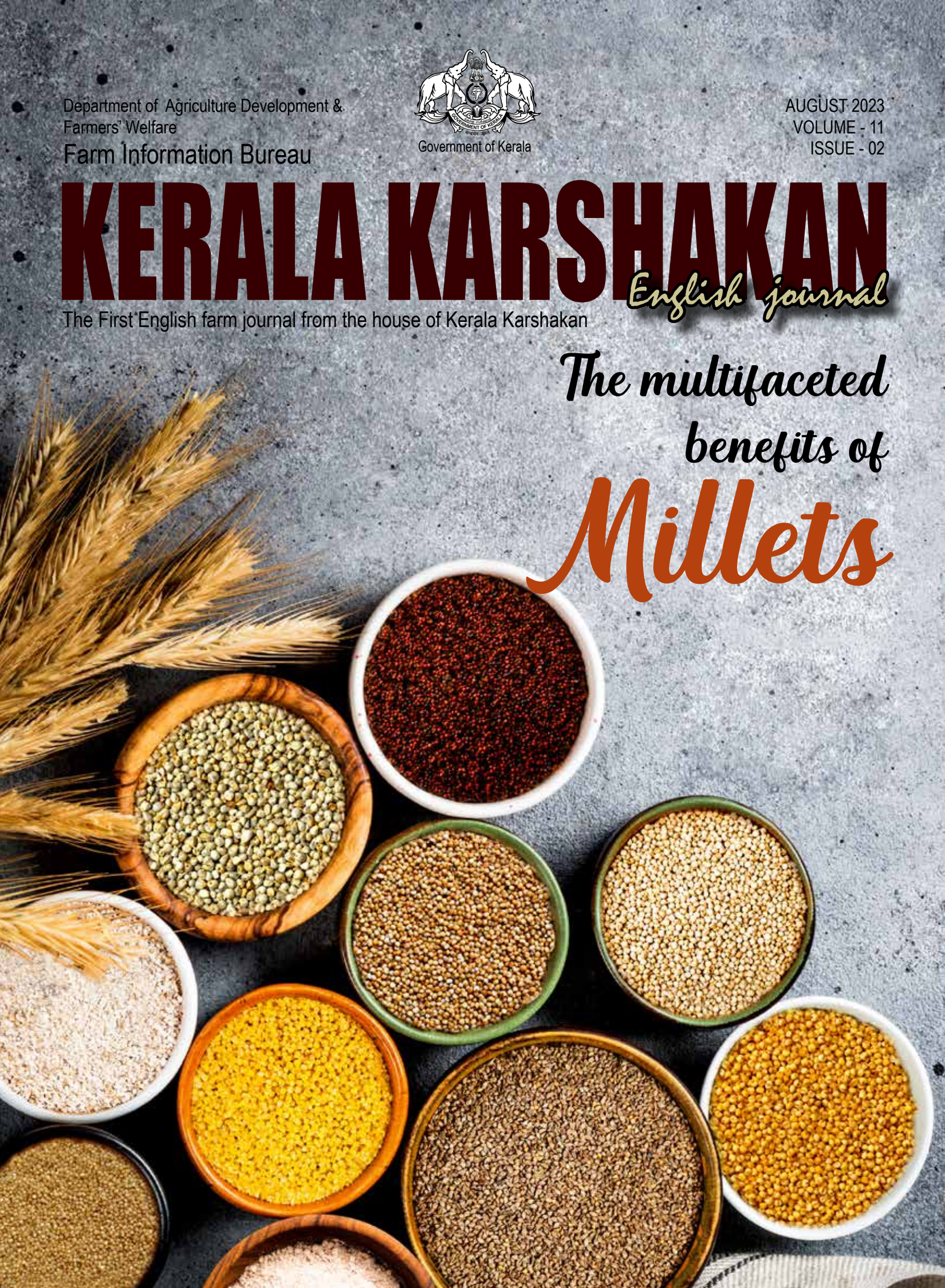
KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

The multifaceted benefits of Millets



INSIDE

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The First English farm journal from the house of Kerala Karshakan

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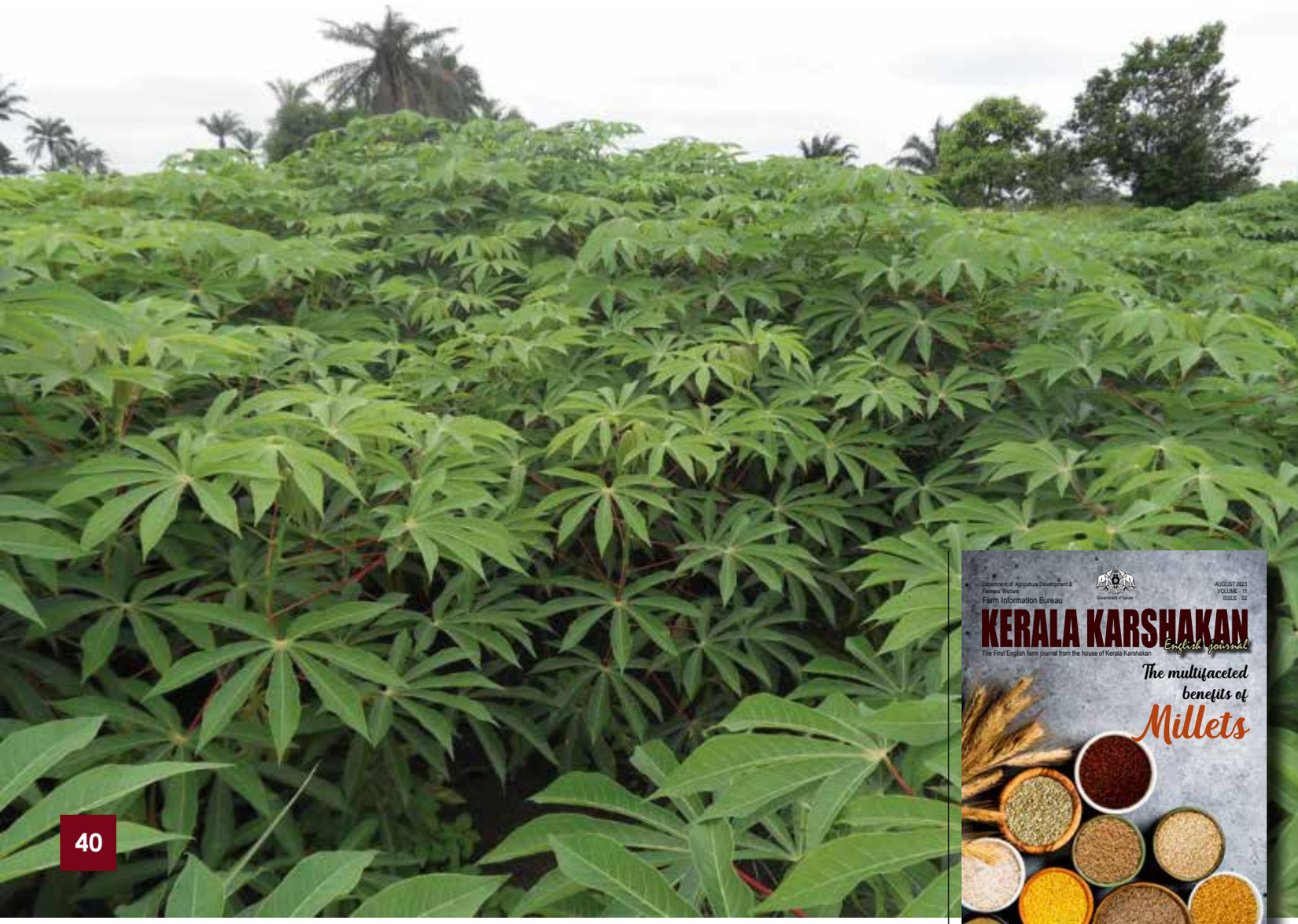

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The multifaceted benefits of Millets

Millets are one of the important crops of dry land agro ecosystems. Millets provide food and fodder security to dryland agricultural communities. These crops are highly tolerant to adverse environmental conditions and are rich in nutrients. Hence called Nutri-cereals. They are often the last surviving crops in drought seasons and will be the sustainable future food source. Major millet crops include sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*), finger millet (*Eleusine coracana*) and minor millets include foxtail

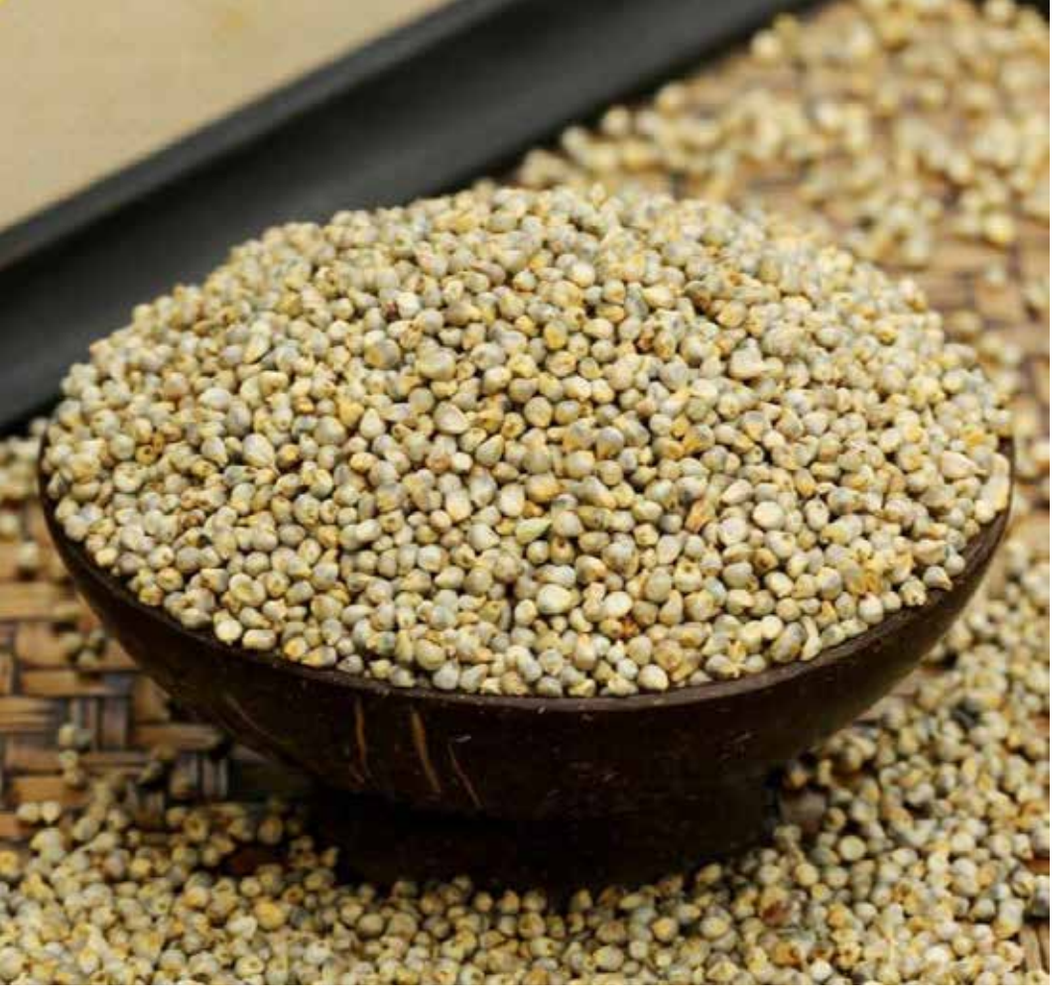
Milllet	Production	Area of Production
Pearl millet	10.1 milliontonnes	7.4 million ha
Sorghum	4.63 milliontonnes	4.35 million ha
Finger millet	1.58 milliontonnes	1.1 million ha
Other millets	0.35 milliontonnes	0.44 million ha

millet (*Setaria italica*), little millet (*Panicum antidotale*), kodo millet (*Paspalum scrobiculatum*), barnyard millet (*Echinochloa frumentacea*), proso millet (*Setaria italica*) and brown top millet (*Brachiaria ramosa*).

United Nations has declared 2023 as international year of millets following the proposal by India.According to the FAO Director-General QU Dongyu, "Millets can play an important role and contribute to our collective efforts to empower smallholder farmers, achieve sustainable development, eliminate hunger, adapt to climate change, promote biodiversity, and transform agrifood systems".

Millets has made its roots in Indian history and tradition for a long time.In India, millets have been mentioned in some of the oldest Yajurveda texts, identifying foxtail millet, Barnyard millet and black finger millet, thus indicating that millet consumption was very common, pre-dating to the Indian Bronze Age (4,500BC). Until the large scale investments in paddy and wheat promotion through the green revolution, millets were the staple grains of large section of

Finger millet



Pearl Millet

the population, that did not have access to assured irrigation for their lands.

A total of about 16.9 million tonnes of millets are produced in India from nearly 12.7 million ha area, which constitutes about 6% of the national food grain basket, making India the leading producer of millets. Pearl millet, sorghum and finger millet account for more than 95% of the area under millets, while small millets comprising of barnyard millet, foxtail millet, little millet, kodo millet and proso millet constitute less than 5% of the area (Directorate of Economics and Statistics, DA&FW 2021)

Cultivation aspects

Millets require warm climate for germination and development and are sensitive to frost. They are mostly sown during the month of July. Their water requirement is extremely low and thus they can be cultivated in extreme climate conditions.

General cultivation requirements of Millets are:

1. Soil and Climate: Millets can be grown in a wide range of soils, but they prefer well-drained, fertile soil. They can also tolerate a range of climatic conditions, from hot and dry to cool and wet. Different types of millets have different requirements, so it's important to choose the right type of millet for the local soil and climatic conditions.

2. Seed Selection and Planting: Selecting good quality seeds is important for a successful millet crop. Millet seeds should be sown at the right time, which varies depending on the type of millet and the local climate. Millets can be planted by broadcasting the seeds or by

Sorghum

Food grain	Carbohydrates (g)	Protein (g)	Fat (g)	Energy (KCal)
Pearl Millet	67.5	11.6	5.0	361
Sorghum	72.6	10.4	1.9	349
Finger millet	72.0	7.3	1.3	328
Foxtail millet	60.9	12.3	4.3	331

using drills.

3.Irrigation and Fertilization: Millets require regular irrigation during growing season, especially during dry periods. Fertilizer application is also important for maximizing yields. The amount and type of fertilizer will depend on the soil type and the type of millet being grown.

4. Weed Control and Pest Management: Millet crops need to be protected from weeds and pests that can reduce yields. This can be done through regular weeding and the use of chemical or organic pest control methods.

5.Harvesting and Storage: Millet crops are typically harvested when the seeds are fully mature and have turned golden brown. The crop can be harvested by hand or with machinery. After harvesting, the seeds should be dried and stored in a cool, dry place.

With proper care and management, millets can be a profitable and sustainable crop for farmers.

Nutritional Aspects

Millets are nutritious and healthy food that can be incorporated into a balanced diet. They are also gluten-free, making them a good option for those with gluten intolerance or celiac disease.

They are rich in micronutrients, including calcium, iron, phosphorus, etc. One hundred grams of ragi grain, for instance, contains 344mg of calcium, compared to only 33mg in rice and 30mg in wheat (Ramadurai, 2023).

They possess low Glycemic Index (GI) as such

Foxtail millet

don't cause huge spike in blood sugar. Dietary fibre in millets has water absorbing and bulking property. It increases transit time of food in the gut which helps in reducing risk of inflammatory bowel disease and acts as detoxifying agent in the body. Millets have fewer cross-linked prolamins, which act as an additional factor contributing to a higher digestibility of millet proteins.

Here are some key nutrients found in millets:

1.Carbohydrates: Millets are a good source of complex carbohydrates, which provide sustained energy to the body. They are also low in glycemic index, which means they do not cause a sudden spike in blood sugar levels.

2.Fiber: Millets are a good source of dietary fiber, which helps promote digestive health, lowers cholesterol levels, and reduces the risk of heart disease and diabetes.

3.Protein: Millets contain a good amount of protein, making them a good plant-based protein source for vegetarians and vegans.

4.Vitamins: Millets are a rich source of vitamins, including Vitamin B such as niacin, thiamin, and riboflavin, as well as Vitamin E.

5.Minerals: Millets are rich in minerals like iron, magnesium, phosphorus, and potassium. These minerals play a crucial role in maintaining strong bones, regulating blood pressure, and promoting overall health.

Economic aspect of millets

The economics of cultivating millets when compared to cereals can vary significantly, depending on various factors such as climate, soil, availability of water, and demand for the crops. In general, cereals such as rice and wheat are more widely cultivated and consumed worldwide, and hence, they have a more significant market demand, resulting in higher prices for the farmers. However, cereals require a lot of water for cultivation, making them less suitable for regions with limited water availability, resulting in lower yields and profitability for the farmers.

On the other hand, millets are hardy and can thrive in dry and arid regions, making them a more sustainable crop in terms of water usage. Moreover, millets require fewer fertilizers and pesticides, making them less costly to cultivate, and their shorter growth cycle results in a quicker harvest and less risk of crop failure. However, since millets lack market demand as not widely consumed, their prices can be lower than cereals, resulting in lower profits for the farmers.

Overall, the economics of cultivating cereals versus millets depends on various factors such as water availability, soil quality, demand, and cost of cultivation. However, given the environmental benefits and nutritional value of millets, their cultivation can be a more sustainable and profitable option in regions where water availability is limited, and the demand for millets is rising due to increasing awareness of their health benefits.

Conclusion

In conclusion, millets are highly nutritious, gluten-free, and have a low glycemic index, making them an ideal food for maintaining good health. They are also adaptable to different climates and can be grown in dry and arid regions, making them a sustainable and eco-friendly food source. The cultivation and consumption of millets can play a significant role in promoting food security and sustainable agriculture. Therefore, millets should be promoted and included in diets worldwide to ensure better health and a sustainable future for all.

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FUTURE POTENTIAL OF SMART WEED MANAGEMENT SYSTEMS TO REVOLUTIONISE AGRICULTURE

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The agricultural sector has advanced towards more productive and sustainable farming methods. Weed management is one of the grey areas which needs a lot of attention because it can have a negative impact on crop yields and overall farm productivity due to herbicide toxicity and improper weed management. Traditional weed control techniques frequently involve manual labour or the use of chemical herbicides, which can be costly, time-consuming, and harmful to the environment.Fortunately, technological developments have led to the development of intelligent weed management systems, revolutionising the farmers to manage the weeds. These ground-breaking systems give farmers efficient, focused, and eco-friendly weed control options by fusing the power of artificial intelligence, machine learning, and precision agriculture.

Smart Weed Management Systems

Smart Weed Management Systems are technologically advanced solutions that integrate sensors, data analytics, machine learning and automation to optimize weed management in agriculture.These systems employ sensors to detect and identify weeds, collecting data on their presence, density and distribution. Using machine learning algorithms and data

analytics, it provides real-time insights and decision support, guiding farmers on targeted weed control strategies. Precision application technologies enable precise herbicide application, reducing environmental impact. Robots or autonomous vehicles are used for weed detection and targeted spraying.

Modern agriculture is increasingly using smart farming technologies like smart sensors, remote sensing, air vehicles, satellites, and the Internet of Things (IoT) to optimise agricultural production, waste reduction and costs. Innovative technological solutions called smartweed management systems were developed to deal with the difficulties in weed management in agriculture. These systems give farmers more effective, focused, and environment friendly weed management options by utilising cutting-edge technologies like artificial intelligence, machine learning, remote sensing, and precision agriculture. The ability of smartweed management systems to precisely detect and identify weeds is one of their key characteristics. They collect information on weed species, density, and distribution in the field using high-resolution imaging, satellite imagery, drone-based remote sensing and other sensing technologies. Advanced algorithms are then used to process this data to analyse huge datasets and give farmers insightful information.

Smartweed management systems can produce weed maps and identification reports by analysing the data gathered, giving farmers the information, they need to choose for effective weed control measures. Farmers can precisely identify weed-infested areas and perform site specific weed control measures using herbicides sparingly and posing a lower risk of environmental contamination.

Smart Weed Management Systems-methods

A. Weed Detectors in Smart Weed Management Systems

There are two main approaches in agricultural weed detection: one-stage weed detectors and two-stage weed detectors. These approaches differ in their methodology and complexity.

1. One-Stage Weed Detectors:

One-stage weed detectors are systems that directly classify the plants as either weeds or crops based on their visual characteristics. These detectors typically use computer vision techniques to analyse images or video frames captured in the field. They extract relevant features from the plant images and use machine learning algorithms to classify them as weeds or crops.

One-stage weed detectors often utilize computer vision techniques and machine learning algorithms to classify plants directly as weeds or crops. An example of a one-stage weed detector is the "WeedNet" system developed by Barbedoet al. (2018). WeedNet uses convolutional neural networks (CNNs) to analyse images captured in the field and classify

plants as either weeds or crops based on their visual features. The system provides real-time weed detection and can be implemented on autonomous agricultural robots or drones.

Advantages

- One-stage weed detectors allow for quick and efficient weed detection over large areas, saving valuable time compared to manual scouting. This enables faster response and intervention in weed management practices.
- These detectors provide instant weed detection capabilities, allowing farmers to promptly identify weed presence in the field.
- Real-time information is crucial for timely decision-making and implementing appropriate weed control measures.

Disadvantages

- One-stage weed detectors are designed to accurately detect specific weed species, their effectiveness may vary depending on the diversity of weeds present in the field.
- Some less common or newly emerging weed species may not be accurately identified, limiting the system's overall effectiveness.
- One-stage weed detectors can be expensive to acquire and maintain, especially when advanced sensing technologies are involved.
- One-stage weed detectors are typically designed for specific crop types or weed management systems. Adapting the detectors to different crops or changing weed management practices may require adjustments or modifications to the system, which could be time-consuming or costly.

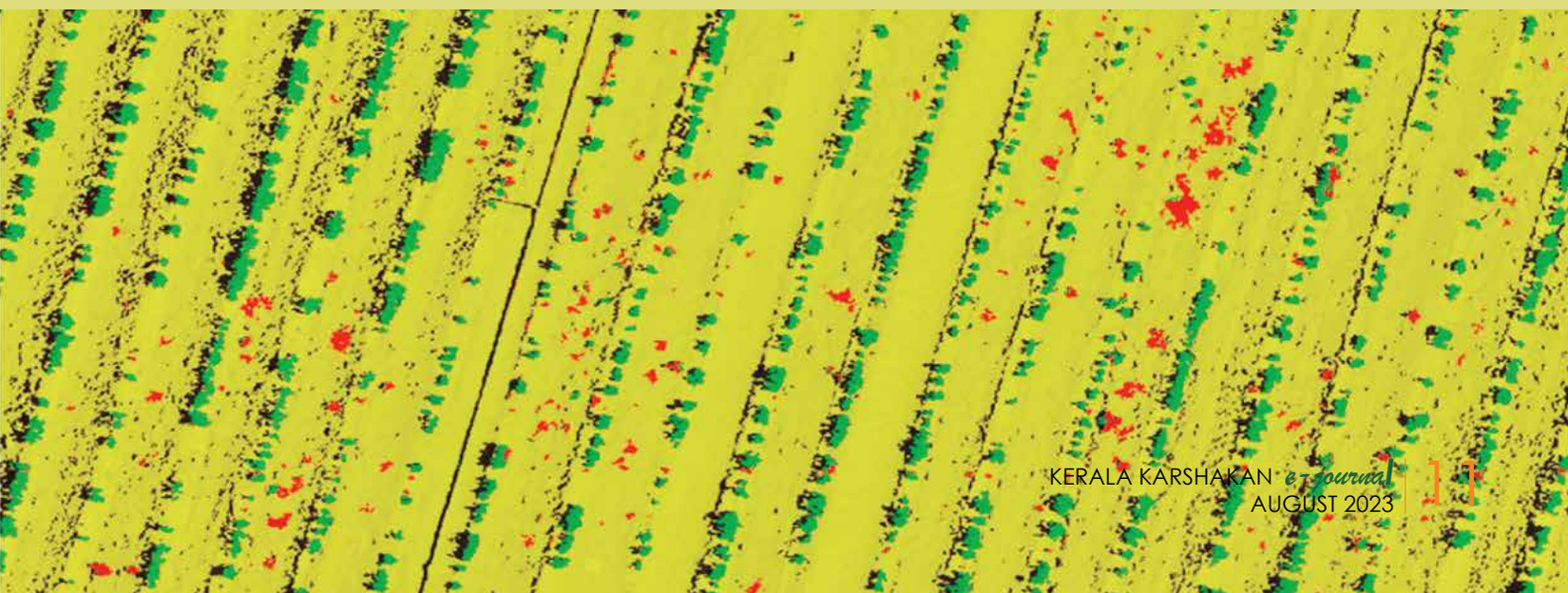
2. Two-Stage Weed Detectors:

Two-stage weed detectors employ a more complex methodology that involves an initial detection stage followed by a weed species classification stage. In the first stage, the system detects and localizes the presence of plants in the field, without specifically identifying them as weeds or crops. This stage often utilizes computer vision techniques such as object detection algorithms to identify and outline the plants in the images.Once the plants are detected, the second stage focuses on classifying the plants as either weeds or crops and may further classify weed species if required. This stage involves more advanced machine learning techniques, such as deep learning algorithms, to accurately classify the plants based on their visual characteristics.

Two-stage weed detectors involve an initial detection stage followed by a weed species classification stage. An example of a two-stage weed detector is the "DeepWeeds" system developed by Fuentes et al. (2017). In the first stage, DeepWeeds uses a Faster Region-based Convolutional Neural Network (Faster R-CNN), You Only Look Once (YOLO) object detection network to detect and localize the presence of plants in the field. Once plants are detected, in the second stage, a deep learning model based on a combination of convolutional and recurrent neural networks is employed to classify the plants into specific weed species. This two-stage approach allows for accurate weed species identification.

Advantages

- Two-stage weed detectors often employ a multi-step process, involving initial



detection and subsequent refinement.

- Two-stage approach can enhance the accuracy of weed detection by reducing false positives and improving the precision of weed identification.
- Two-stage detectors can be more adaptable to different weed species compared to single-stage detectors.
- Two-stage process undergo more analysis and learning of specific weed characteristics, making it easier to generalize and detect a broader range of weed species.

Disadvantages

- Two-stage weed detectors are typically more computationally intensive and may require more processing power and time compared to one-stage detectors.
- Designing and implementing two-stage weed detectors can require additional effort in terms of algorithm development, training, and fine-tuning.
- Due to the multi-step nature of two-stage detectors, it hasa slightly slower processing speed compared to single-stage detectors.

B. Agricultural Unmanned Aerial Vehicles (UAVs)

The integration of unmanned aerial vehicles (UAVs)/ drones into smart weed management systems has revolutionized the way farmers tackle weed infestations in agriculture. These UAVs equipped with advanced sensors and imaging technology offer a range of capabilities, from high-resolution aerial mapping to targeted herbicide applications. Role of Drones in Smart Weed Management Systems

1. Aerial Weed Mapping and Surveillance:

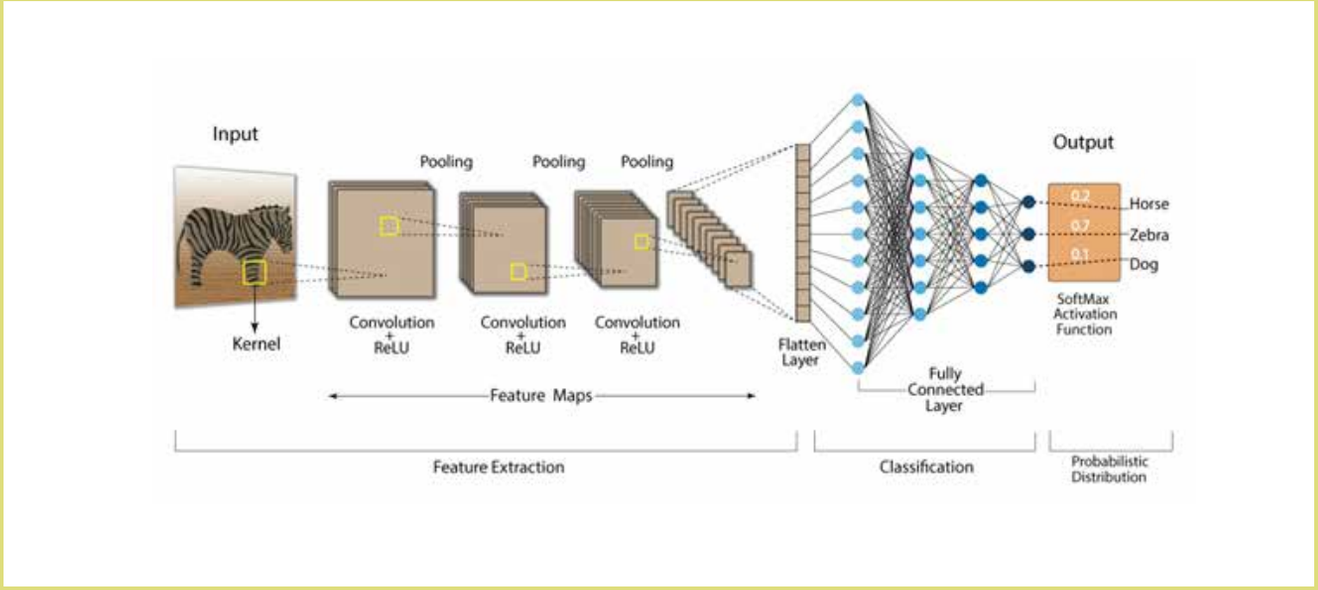
Drones provide a bird's-eye view of agricultural fields, enabling efficient and accurate weed mapping and surveillance. Equipped with high-resolution cameras or multispectral sensors, drones capture detailed imagery of the entire field, creating maps and plant health indices. These maps highlight weed hotspots, allowing farmers to identify infested areas, monitor weed growth patterns, and make data-driven decisions for effective weed management strategies.

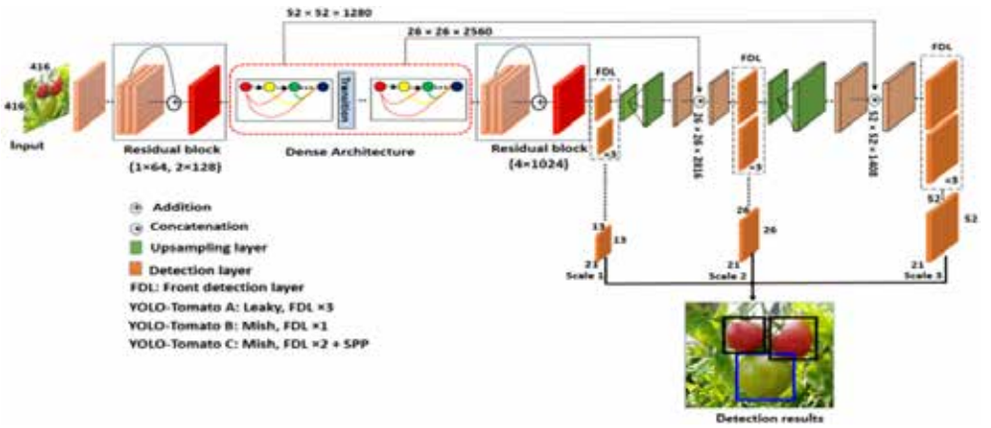
2. Rapid Weed Detection and Identification:

Advanced imaging capabilities of drones, combined with machine learning algorithms, facilitate rapid and automated weed detection and identification. Drones capture images of the field, and the collected data is processed using computer vision techniques and deep learning models. This analysis enables real-time identification of weeds, distinguishing them from crops and providing actionable information for targeted intervention.

3.Precision Herbicide Application:

Drones equipped with precision spraying systems have revolutionized the way





herbicides are applied in weed management. By utilizing real-time weed maps generated from aerial surveys, drones can precisely target weed-infested areas, delivering herbicides only where needed. This targeted approach minimizes herbicide drift, reduces chemical usage, and lowers environmental impact. Additionally, drones can reach difficult-to-access areas, such as steep slopes or dense vegetation, where manual spraying would be challenging or dangerous.

C. Robotics in Smart Weed Management Systems

Robots have become cutting-edge technology in the field of smartweed management systems, revolutionising the way farmers fight weed infestations. With their cutting-edge sensors, imaging equipment, and robotic arms, these autonomous or semi-autonomous machines are capable of everything from precise weed detection to precise herbicide application. This article will examine the role of robots in intelligent weed management systems, their advantages, and the revolutionary changes they are bringing about in contemporary agriculture.

1. Autonomous Weed Detection

Robots used in smart weed management systems are built to autonomously navigate agricultural fields and find weeds. These robots, which are outfitted with cameras, lidar sensors, or hyperspectral imaging apparatus, take high-resolution pictures and gather information about the vegetation

that is present in the field. They can distinguish between crops and weeds with astounding accuracy using computer vision algorithms and machine learning techniques, enabling accurate weed mapping and identification.

2.Application of Targeted Herbicide

One of the main benefits of robots in smart weed management is their capacity to apply targeted herbicides. Robots can precisely locate and apply herbicides only to weed-infested areas using real-time weed maps created from weed detection. With this focused strategy, the use of herbicides is decreased, the environmental impact is reduced and resource allocation is improved. Some robots can precisely deliver herbicides to specific weeds using robotic arms or nozzles, increasing accuracy and efficiency.

3.Increased Efficiency and Cost Savings

Robotic weed control operations are more effective and less expensive because of their increased efficiency. Since they can run continuously, these machines can cover a lot of area in a short period. They don't require manual labour thanks to their autonomous or semi-autonomous capabilities, which lowers labour costs and boosts operational effectiveness. Robotic weed control also ensures consistency and timeliness regardless of environmental factors because they can operate in varied weather and terrain conditions.

4.Scalability and Adaptability

Robots in smart weed management systems can scale and adapt to various farming operations. Robots can be programmed to recognize and target particular weed species or to adjust to various crop configurations. Due to their adaptability, robotic weed management systems can be implemented by farmers of all sizes and customised to meet their unique requirements.

Conclusion

Smartweed management systems have ushered in a new era of precision and efficiency in agriculture. With the integration of advanced technologies such as one-stage weed detectors, deep learning algorithms, drones, and robots, farmers now have powerful tools at their disposal to combat weed infestations effectively. These technologies offer a range of benefits, including real-time weed detection, high accuracy, reduced herbicide usage, cost savings, improved labour efficiency, and minimized environmental impact.

Baby Sunrose

A Perfect Replacement for Turtle Vines in Your Hanging Baskets

When it comes to beautifying your hanging baskets, finding the ideal plant that combines aesthetics, versatility, and ease of care can be a daunting task. However, the Baby Sunrose *(Mesembryanthemum cordifolium)*, also known as Heartleaf Ice Plant, emerges

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as a delightful option. With its vibrant flowers and lustrous green cascading foliage, the Baby Sunrose offers a compelling alternative to traditional choices like turtle vine. This article explores the various aspects of the Baby Sunrose, including its utility in landscaping, propagation methods, cultural practices, pest and disease management, and even its medicinal values.

General Description

M. cordifolium, generally known as Baby Sunrose, is a member of the Aizoaceae family. The plant was initially considered as ground cover, and its origin can be attributed to South Africa. It constitutes a vast majority of the South African succulent flora families. The Aizoaceae family consists of nearly 143 genera and 2300 species. The genus Aptenia is derived from the Greek word apten, meaning wingless, in accordance with their wingless capsule. There are annual and perennial herbs in this genus, with succulent leaves and stems. The plants are generally dwarf and compact shrubs, but certain species can reach a height of up to 1 meter. The leaves are glistening in nature due to the presence of prominent water-containing bladder cells. Baby Sunroses have heart-shaped leaves that are glossy and fleshy, providing an attractive backdrop to the abundant flowers. These flowers exhibit a striking array of colors, ranging from vivid

pinks, purples, and oranges to vibrant yellows. When in full bloom, the Baby Sunrose creates a captivating visual display, making it an excellent choice for hanging baskets and other containers.

Utility in Landscaping

In landscaping, the Baby Sunrose shines as a versatile plant. Its trailing habit and abundant flowering make it an ideal candidate for hanging baskets, window boxes, and cascading containers. Under Kerala conditions, homestead gardeners are really fond of container gardening and hanging baskets; therefore, this can be a perfect plant for gardeners to pick. The plant's adaptability to tolerate drought and differing soil types makes it suitable for rock gardens, coastal landscapes, and arid regions. Additionally, Baby Sunroses serve a wide utility in ground covers, preventing soil erosion and adding color to slopes or barren areas.

Methods of Propagation and Plant care:

Propagating Baby Sunrose can be accomplished through various methods, including seeds, stem cuttings, or division. Seeds should be sown in well-draining soil, while stem cuttings should be taken during the active growth phase and allowed to dry before planting. Division can be carried out by separating rooted sections of the plant. Baby Sunrose thrives in full sun or partial shade, preferably in a location with well-draining soil. Watering should be done sparingly, allowing the soil to dry between waterings to prevent root rot. The plant is adaptable to different soil pH levels but prefers slightly acidic to neutral conditions. Regular pruning helps maintain the plant's shape and promotes bushier growth.

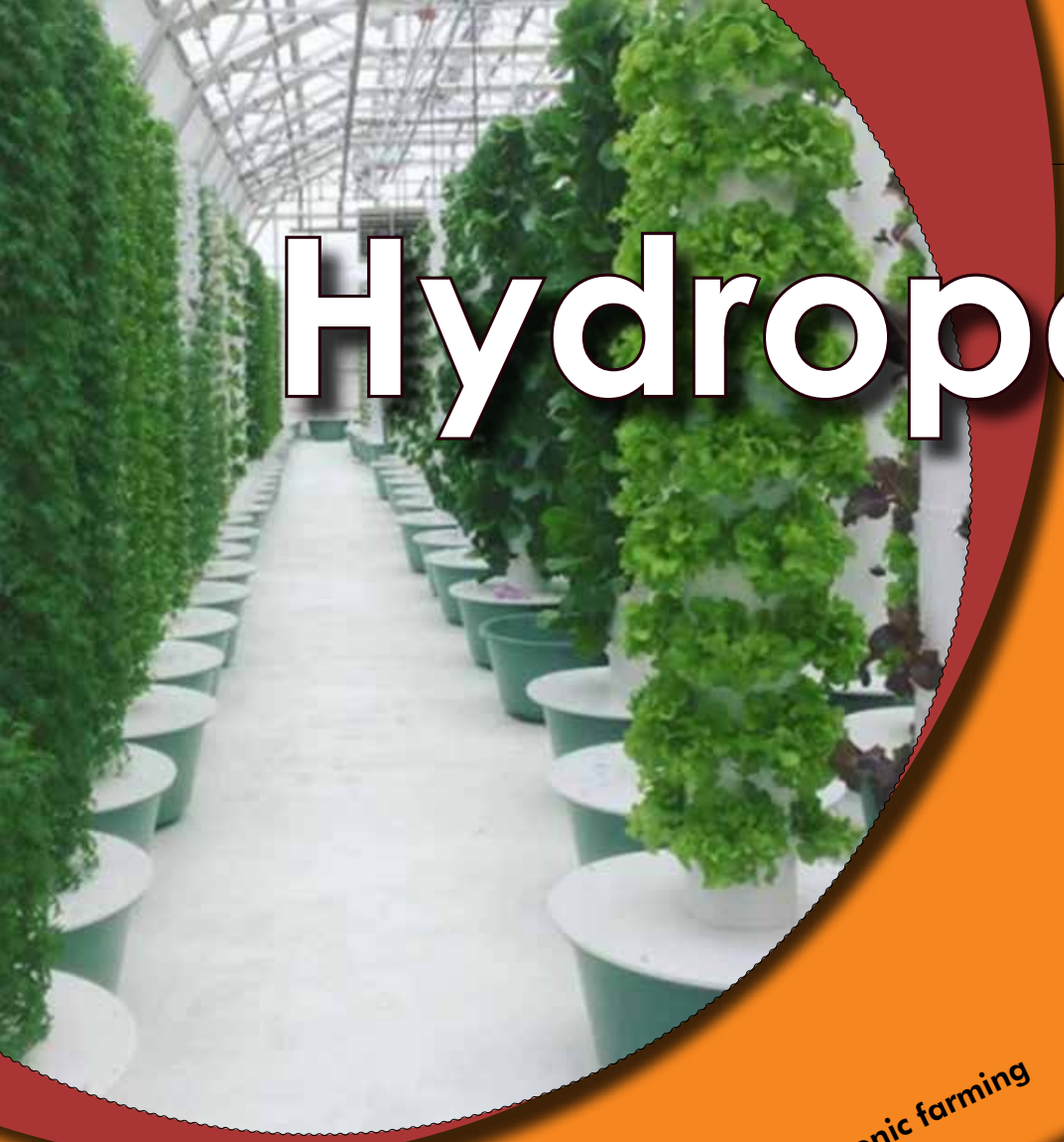
Pests and Diseases:

Fortunately, the Baby Sunrose is generally resilient against pests and diseases. However, overwatering can lead to root rot, so it is crucial to provide adequate drainage. Mealy bugs and aphids may occasionally infest the plant, but they can be controlled through organic methods like botanicals or homemade insecticidal formulations.

Medicinal Values:

Apart from its ornamental attributes, Baby Sunrose possesses medicinal properties. Traditionally, the plant has been used to treat burns, wounds, and rashes due to its soothing and healing properties. Various classes of compounds have been isolated from M. cordifolium, such as sterols, acids, alkaloids, oxyneolignans, lignans, and amides. M. cordifolium has shown powerful anti-inflammatory activity and a negative Schistosomicidal effect. Further investigations are underway for the isolation of quality phytochemicals from the species.

In conclusion, the Baby Sunrose offers a delightful alternative to traditional choices like turtle vines for your hanging baskets. With its vibrant flowers, cascading foliage, and low maintenance requirements, it is an excellent addition to any landscape. Its adaptability, ease of propagation, and resistance to pests and diseases make it a suitable choice for both experienced gardeners and beginners. Furthermore, its medicinal values add an extra layer of value to this beautiful plant. So, why not consider the Baby Sunrose as your next hanging basket companion?



Grow tower system

Hydroponic

A modern tool in Ornamental Horticulture

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Vertical hydroponic farming

Introduction

Floricultural products have become a major source of income in the international agricultural market so that quality production became major concern during these days. The word hydroponics is derived from two Greek words hydro' means water and ponos' means labour. Hydroponics or Soilless culture is a technology for growing plants in nutrient solutions. The solution consists of all nutrient elements which are essential for optimum plant growth with or without the use of an inert medium. Various media used in hydroponics include expanded

clay balls, gravel, vermiculite, rock wool, peat moss, sawdust, coir dust, coconut fibre etc. This technology proves that soil is not required for plant growth but the elements, minerals, nutrients etc. in it are much essential.

Types of Hydroponics

Hydroponics systems are classified into Solution culture or liquid hydroponics, Solid media culture or aggregate systems and Aeroponics.

Solution culture or liquid hydroponics: Solution culture or liquid hydroponics comprises of circulating methods and non-circulating methods. Nutrient film technique (NFT) and Deep flow technique (DFT) are coming under circulating method in which nutrient solution circulate around the plant root system and it can be collected, replenished and reused as per the need. Non circulating method comprises of root dipping technique and capillary action technique. In non-circulating open system nutrient solution is not circulated but it can be used only once for a longer duration depending upon the EC and PH. In NFT technique plant roots are exposed to thin film of nutrient solution (1mm thick) flowing through the channel. The length of the channel varies from 15-10m kept at a slope. Deep flow technique systems are often deeper than NFT. Plants in DFT system usually float on the surface.In root dipping technique the bottom 2-3 cm of the pot is submerged in the nutrient solution and roots may be partially submerged in the solution. Floating technique have plants in styrofoam sheet or other similar light plate on nutrient solution. In capillary action technique nutrient solution rises to the pot filled with porous material by the capillary pot action. This technique is suitable for ornamental and indoor plants.

Hydroponic living wall

Inorganic media		Organic media
Natural	Synthetic	
Sand	Foam mats (Polyurethane)	Sawdust
Gravel		Black (pine)
Rockwool	Polystyrene foam	Wood chips
Glasswool	Oasis (Plastic Foam)	Peat moss
Perlite		Coir (Coconut fiber)
Vermiculite	Hydrogel	
Pumice	Biostrate Felt (Biobased product)	Rice hulls
Expanded clay		
Zeolite		
Volcanic stuff		

Table - popular media used in hydroponics

Solid Media culture: Solid media with high porosity better aeration and high water and air holding capacity and efficient drainage are used in sterilised form. Cocopeat, perlite, vermiculite,vermicompost,

Element	Form taken up by plants
Nitrogen	NH_4^+, NO_3-
Phosphorous	HPO_4^{2-}, H_2PO_4-
Potassium	K^+
Calcium	Ca^{2+}
Magnesium	Mg^{2+}
Sulphur	SO_4^{2-}
Iron	Fe^2+, Fe^{3+}
Copper	Cu^{2+}
Zinc	Zn^{2+}
Manganese	Mn^{2+}, Mn^{4+}
Boron	H_3BO_3, $BO3^-$, B4O2-
Molybdenum	MoO_4^{2-}

Plug tray hydroponic nursery

gravel, rockwool, sawdust, coconut fibre, expanded clay balls etc. are used.

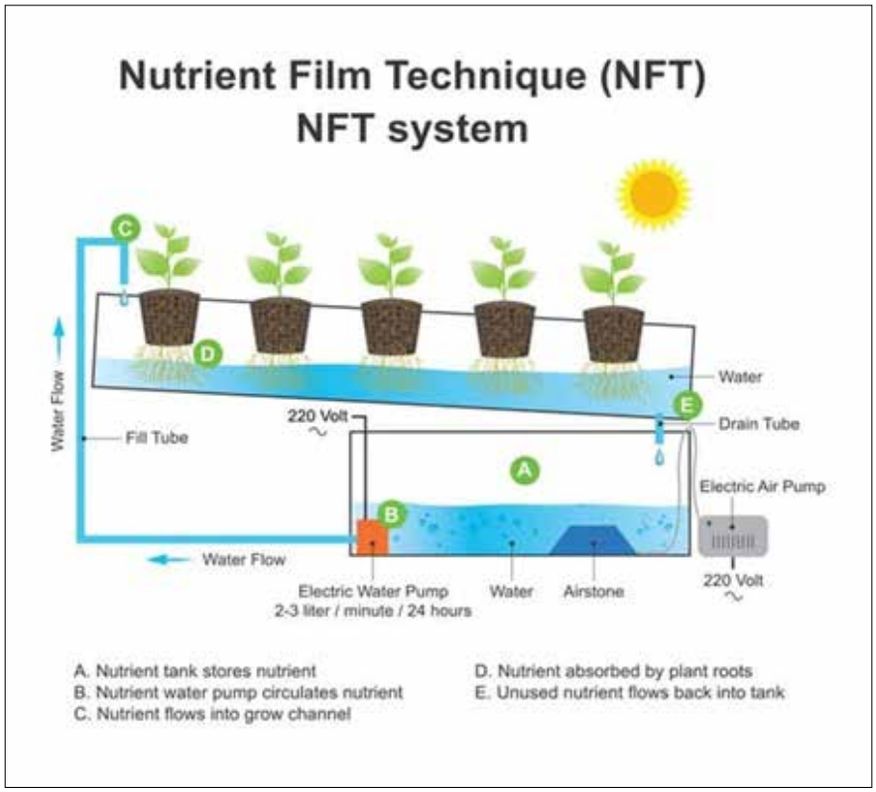
Aeroponics: Plants are secured in gaps in styrofoam boards and their roots are suspended air underneath on board. The supplement arrangement is splashed in fine fog Structure to the roots. Moistening is accomplished for a couple of moments in each 2-3 minutes. It is used in many grow tower commercial systems.

Nutrient solution for hydroponics

Plant nutrients for hydroponics are mostly in inorganic and ionic forms. These

	Concentration of stock solution (mM)	Grams of compound used (g)	Volume of stock solution per liter (ml) for full strength
	Macronutrients		
KNO_3	1,000	101.10	6.0
$Ca(NO_3)_2 \cdot 4H_2O$	1,000	236.16	4.0
$NH_4H_2PO_4$	1,000	115.08	2.0
$MgSO_4 \cdot 7H_2O$	1,000	246.48	1.0
	Micronutrients		
KCl	25	1.864	2.0
H_3BO_3	12.5	0.773	2.0
$MnSO_4 \cdot H_2O$	1.0	0.169	2.0
$ZnSO_4 \cdot 7H_2O$	1.0	0.288	2.0
$CuSO_4 \cdot 5H_2O$	0.25	0.062	2.0
H_2MoO_4 (85% MoO_3)	0.25	0.040	2.0
*Na·Fe·DTPA (10% Fe)	53.7	30.0	0.3-1

Hoagland and Arnon solution



are usually water soluble in nature.

All the essential elements needed for plant growth are supplied through different chemical combinations. Thereby development of a nutrient solution that provide a favourable ratio of ions for plant growth and development can be made possible. The point that is to be kept in mind while developing a nutrient solution is that nutrient uptake by plants can only proceed when they are present in available form for absorption.

While considering the nutrients, they get absorbed either in anionic or cationic forms. Form of nutrients absorbed by plants in a nutrient medium is given in the table.

There are so many standard nutrient solutions available now a days which include Hoagland and Arnon solution, Albert mixture, Dr.alan cooper formula, Saparamandu solution, Mattson and Peters solution, Steiner solution, Bollard solution etc. Also self-made recipes are available from many growers all over the world. Hoagland and Arnon solution

Floriculture crops grown under hydroponics

Hydroponic flower gardens produce high quality plants and flowers by reducing the effect of pest and disease and encourage faster growth. Rose, carnation, Chrysanthemum, gerbera, marigold, orchid, tulips, ornamental foliage plants etc. can be grown successfully under hydroponics. Plug tray nursery under hydroponics is gaining much acceptance now a day.

Modern applications of hydroponics

Vertical hydroponic farming: Many vertical farms choose to use hydroponics as a method of feeding their plants. The efficiency of water consumption goes up to 97 % as compared to traditional methods of cultivation in vertical hydroponic systems. 10 hectares of agricultural field can be substituted by a hectare of a greenhouse recirculating vertical hydroponic system.

Grow tower system: A tower garden, also called as a window farm and it is a system of vertical hydroponics. It is popular in urban areas where only a small space is available for gardening.

Cocopeat

Perlite

Vermiculite

Vermi compost

Gravel

Rock wool

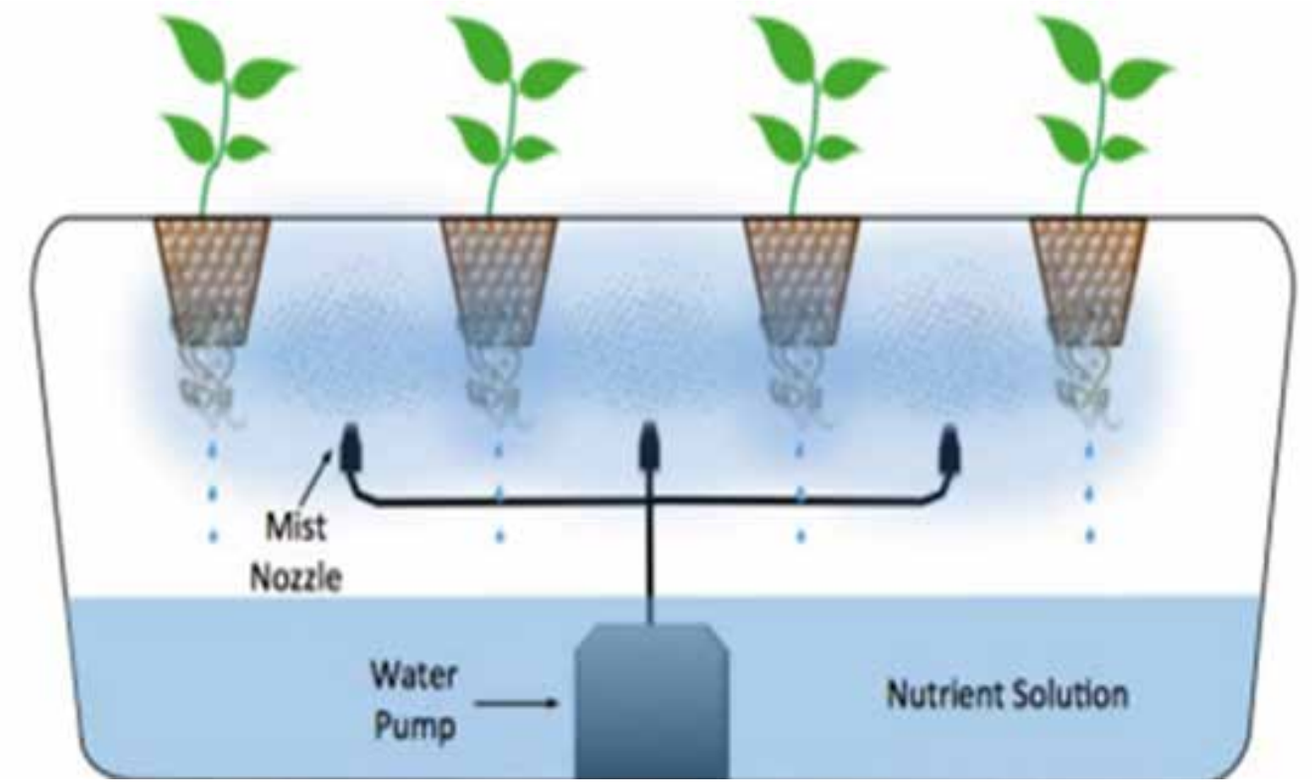
Saw dust

Coconut fibre

Expanded clay balls

Tower gardens includes A-Frame hydroponic system, hydroponic wall and cascades of bottles. It can be used for growing certain flowering crops like petunia, begonias and ornamental foliage plants which kept in indoor or outdoor conditions.

Hydroponics in space: Now scientists are trying to find a way for them to grow their own food in space. Researches were done for their Control Ecological Life Support System (CELSS). Hydroponics intended to take place on Mars are using LED lighting for growing in different colour spectrums with much less heat. Aeroponics with root mist systems are generally used by NASA. It has been given special attention from NASA since a mist is easier to handle than a liquid in a zero gravity



Aeropinics

environment. Light, temperature and carbon dioxide levels are carefully controlled.

Hydroponic Living wall: Hydroponic living walls are new entrant in urban floriculture. Using a growing medium to cultivate the plants in a hydroponic living wall overcomes the shortcomings of vertically stacked soil while achieving healthier and long-lasting plants.

Advantages of hydroponics

- Require smaller growing area
- Faster plant maturity and higher yield
- Clean working environment
- Continuous cultivation & off-season production is possible
- Great plant quality and taste
- Precise control of the nutrients
- Soil-borne pathogens and diseases avoidance
- No weeds & fewer pests.
- Possibility of growing a wide variety of vegetables and flower crops including anthurium, marigolds, leafy ornamentals etc.
- Automation is possible

Disadvantages of hydroponics

- High initial investment:-A large-scale cultivar may have to purchase instruments to measure
- pH and EC of the nutrient solution, Energy inputs are necessary to run the system
- Economically viable for limited number of crops
- Special skill is required:-High degree of management skill is necessary for solution preparation, maintenance of pH and EC, nutrient deficiency judgement and correction, ensuring aeration, maintenance etc.
- Precision surveillance

Conclusion

Hydroponics will be a technology the world will look into in the future. Hydroponic floriculture can take quality flower production and modern innovations to high standards. However, it needs to be studied, refined and experimented to make it more worthy on commercial scale.

Tinospora cordifolia

(Chittamruthu) A miracle medicinal plant

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Tinospora cordifolia commonly known as Chittamruthu, is a perennial climber belonging to the family Menispermaceae (2n=26). The useful part is stem and it possesses various Indigenous medicinal uses. A study conducted in the 'Department of Plantation, Spices, Medicinal and Aromatic Crops' entitles "Diversity analysis of Chittamruthu [*Tinospora cordifolia*(Willd.)] accessions from the Northern districts of Kerala" revealed that it has been used by inhabitants in Kerala as an indigenous remedy for curing fever, diabetes, jaundice and also as an anthelmintic and anti-rheumatic agent. The genus *Tinospora* include many species. It has got several phytochemicals and possesses in vitro, in vivo and clinically proven pharmacological properties. Many functional products have been made from T. cordifolia.

Tinospora Species

T. cordifolia– Chittamruth is the medicinally important *Tinospora* species and the other species in *Tinospora* genus include T. crispa (Mullamruth), *T. sinensis* (Kattamruth), *T. malabarica* etc. *Tinospora sp.* are dioecious with cordate leaves, grey-white coloured stem, aerial roots, the inflorescence is raceme clustered in male and solitary in females. Morpho-anatomical comparison of *Tinospora* sp. revealed variation in stem and leaf characteristics.T. *cordifolia* possess blunt stem whereas *T. crispa has* prominent protuberances (lenticels) on the stem (Plate No. 1).

Comparing the phytochemicals and heavy metal concentration of various *Tinospora* sp. it was revealed that *T. cordifolia* possessed lower amount of heavy metal concentration thus making it suitable for medicinal pupose (Kerala Agricultural University, 2017).

Diversity analysis of *Tinospora cordifolia*

T. cordifolia accessions collected from different parts of India showed high diversity. Variability was observed in leaf length, leaf breadth, petiole length, leaf area, stem thickness, stem lenticel density etc. Variability was also confirmed by using molecular markers like RAPD, ISSR and SSR etc. Recently, Mahajan et al. (2021) had accomplished genome sequencing in *T. cordifolia*. Ideal genotypes of Chittamruthu from Northern Kerala possessing superior morphological and phytochemical qualities were collected from Mundayad, Kannur and Thavanoor, Malappuram respectively (Dhyana, 2023).

Phytochemicals

T. cordifolia contain several bioactive alkaloids like berberine,tinosporin, jatrorrhizine, magnoflorine, terpenoids like tinosporides, columbin, tinosporon, steroids like 20 δ – Hydroxyecdysoe, Sitosterol, sitosteryl glucoside etc. Phytochemicals in *T. cordifolia* varied according to difference in ecology. Phytochemicals viz., alkaloids, phenols, flavonoids, cardiac glycosides and saponins present in different Chittamruthu ecotypes collected from 13 different agro-ecological units of Kerala were found diverse in its quantity (Dhyana, 2023). Also, studies proved that female vines had high phytochemical potential than that of male vines.

Pharmacological Properties

T. cordifolia possesses hypoglycemic, antioxidant, anti-bacterial, anti-inflammatory and hepato protective activities. In a study, when diabetic rats, were administered with *T. cordifolia* plant extract there observed a significant reduction in its blood glucose level (Chougaleet al., 2009).*T. cordifolia* was one of the medicinal plant recommended by National Medicinal Plant Board and its *in silico* (*in silico* is a computer-based simulation/imitative representation study used to know how a substance interact with pathogens or body proteins) anti-COVID-19 activity of chittamruthu was proved through docking studies (Sonia et al., 2021).

Functional benefits of *Tinospora cordifolia*

Wheat flour Cookies incorporated with 5% *T. cordifolia* leaf and stem powder increased the nutritional composition of the cookies. Additionally, Jain et al. (2021) had developed a whey protein based electro-sprayed nanosphere from *T. cordifolia* extract.

Chittamruthu (*T. cordifolia)* is a matter of research interest from time immemorial. The bio-active compounds it's in vitro, in vivo and clinical potential were validated. In the recent decades its value-added products and nutraceuticals are being explored. The potentiality of the plant is undeniably impressive hence, Chittamruthu can be proclaimed as 'A miracle medicinal plant'.

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COCONUT

Inflorescence The Medicinal Blossom

Introduction

In India, the coconut tree - Cocos nucifera L. has been considered from time immemorial as "Kalpavriksha," literally meaning "a tree of heaven". Over the generations the coconut palm and its products have been an integral part of the way of life of the people in the humid tropics. No other tree has been looked upon with such esteem either in the past or in the present anywhere in the world. The palm products viz., coconut kernel, coconut water, tender coconut, coconut inflorescence etc. are edible as well as ingredients in Ayurvedic

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and folkloric medicines recommended for general wellness and feminine health issues.An anti-diabetic dietary supplement using coconut inflorescence was developed in the Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Agriculture, Vellayani (KAU).This article highlights the importance of coconut inflorescence and some of the research findings of the inflorescence.

Traditional uses

Coconut is an inevitable ingredient in Kerala cuisine and coconut inflorescence is used as an indigenous dietary supplement effected for curing menorrhagia and back pain.Thenginpoonkula adirasyana is a reputed Ayurvedic formulation coconut inflorescence offered for feminine health issues. Coconut inflorescence was used in karkidakachikitsa (monsoon treatment in Ayurveda) and its powder was used in daily diet during olden days as an ingredient in other staple foods viz., idli, dosha, puttu, appam, elayada, etc. believed for the rejuvenation of body.

Reports says that consumption of coconut flowers mixed with curd could cure diabetics and it has aphrodisiac property (Khanna, 1985). Coconut inflorescence added with rice flour, jaggery and coconut oil could cure skin diseases and used as a rejuvenate after child birth (Warrier, 1996). Infusions of coconut inflorescence are taken orally as a remedy for menstrual cycle disorders (Lima et al., 2015). Coconut inflorescence sap (neera, kalparasa) is a phloem sap traditionally tapped from unopened inflorescence of coconut. It is a non-alcoholic beverage rich in protein and is good for post-operative care due to high electrolyte content (Ramesh et al., 2018).

Phytochemical constituents of coconut inflorescence

The nutrient and phytochemical profile of the inflorescence contribute to its exorbitant health benefits. Nagappan et al. (2021) reported that coconut flowers are rich in antioxidants. Methanolic coconut flower extract showed 50% DPPH radical scavenging inhibition at 37 μg concentration. Coconut inflorescence contains carbohydrate, protein, fat, vitamins, minerals etc. but its quantitative data is limited.Chandran (2023) had found

Thenginpoonkula adirasyana

Coconut jaggery

that porridge prepared using coconut inflorescence powder is highly palatable when the inflorescence is harvested at five to six months before opening. During this stage, the inflorescence had high antioxidant activity, 88.77% DPPH free radical

Coconut Flower sugar

Coconut milk powder

inhibition and nutrients viz., carbohydrate (4.67 g 100g-1), protein (8.82 g 100g-1), fat (1.96 g 100g-1), calcium (195.25 mg 100g-1), iron (0.84 mg 100g-1), sodium (16.54 mg 100g-1), vitamin A (973.50 μg 100g-1)and vitamin C (33.46 mg 100g-1).

Traditionally coconut inflorescence powder was added along with cereal flours for preparing breakfast dishes. Today, the use of coconut inflorescence in daily life is diminished due to the advent of more convenient foods. Coconut kernel products are having low glycaemic index and hence, supposed to be similar for the inflorescence. Coconut inflorescence sap was suitable for consumption by diabetic people as it has a lower glycaemic index (GI 35) than table cane sugar (GI 60) (Beegumet al., 2022). When handling the inflorescence for culinary purpose, enzymatic browning cause impairment in sensory attributes due to the presence of phenols. Chandran and Sonia (2022) had standardized a technique to reduce the browning reaction in coconut inflorescence while preparing coconut inflorescence powder. The inflorescence has to be chopped (1cm3 pieces), pre-treat it by soaking in a combination of one percent citric acid and sodium chloride for five minutes, hot-air oven drying at 60^{O}C followed by powdering it. Moreover, the study had developed a dietary supplement suitable for diabetic people using coconut inflorescence powder and a combination of a millet, pulse and an oilseed (Chandran, 2023).

Conclusion

Coconut is an inexorable crop in Kerala. Its inflorescence has innumerable health benefits but value-added products using the inflorescence is limited. A study on the development of ready-to-eat coconut inflorescence dietary supplement is now going on in the department. Further investigations on this topic is essential for exploring its complete potential for the well-being of humans.

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NATURAL FLOWER PIGMENTS AND ITS USE IN FOOD INDUSTRY

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Food additives are defined by FAO and WHO (1956)as non-nutritive substances added intentionally to food, generally in small quantities, to improve its appearance, flavour, texture or storage properties.

The first distinguishing characteristic of a food is its colour, which frequently indicates the quality of the food. Food colours have been found to naturally increase the taste threshold, the perception of sweetness, the attraction, and

the acceptability of the food, all of which have a direct impact on the choice of food (Nayaket al., 2007). Turmeric, beets, saffron, and Kashmiri chilli powder are a few traditional and natural colours. However, a lot of business owners, caterers, and producers of processed foods prefer artificial colours since they are affordable, give products a rich colour, and improve their appearance, quality, and shelf life (Saharet al., 2012). Over the past century, artificial food colouring has been used to enhance food appearance and stimulate appetite. However, application of synthetic food colouring chemicals has dramatically increased in emerging nations. Synthetic colours have been used indiscriminately in recent years, especially in food that is mostly consumed by children.

NEED FOR FOOD COLOURING

Colour variation in foods throughout the season's and the effects of processing and storage often make colour addition commercially advantageous to maintain the colour expected or preferred by the consumer. Some of the primary reasons include,

- Offsetting colour loss due to light, air, extremes of temperature, moisture, and storage conditions
- Masking natural variations in colour
- Protecting flavours and vitamins from damage by light

- Decorative or artistic purposes such as cake icing
- To enhance colours that occur naturally
- To restore the colours lost during processing
- To provide colour to colourless and "fun" foods
- To make food more attractive, appetizing and informative
- To allow consumers to identify products on sight

REGULATION

Many organisations across the world test food colorings for safety, and sometimes different organisations have differing opinions on the safety of food colouring. Synthetic food dyes that do not occur in nature are approved in the United States using FD&C numbers (which typically signify that the FDA has approved the colourant for use in foods, drugs, and cosmetics), whereas in the European Union, E numbers are used for all additives, both synthetic and natural, that are approved for use in food applications. The majority of other nations have their own laws and lists of food colours that can be utilised for a variety of purposes, including daily intake maximums. Many regulatory organisations around the world, including the European Union, need not require natural colours to be evaluated"Color additives exempt from certification" for food are listed by the FDA in subpart A of Title 21 Part 73 of the Code of Federal Regulations. However, some of the items on this list might be synthetic in nature. There are 28 colours that can be used in cosmetics and pharmaceuticals, but only 26 can be used in food.

There are major three categories of food colours;

1) Natural colours
2) Synthetic colours
3) Lakes and dyes

NATURAL FOOD COLOUR

Natural Food Colour is any dye, pigment or any other substance obtained from vegetable, animal, mineral, or source capable of colouring food drug, cosmetic or any part of human body, colours come

CHILLI POWDER

from variety of sources such as seeds, fruits, vegetables, algae & insect.A growing number of natural food dyes are being commercially produced, partly due to consumer concerns surrounding synthetic dyes. Some examples include:

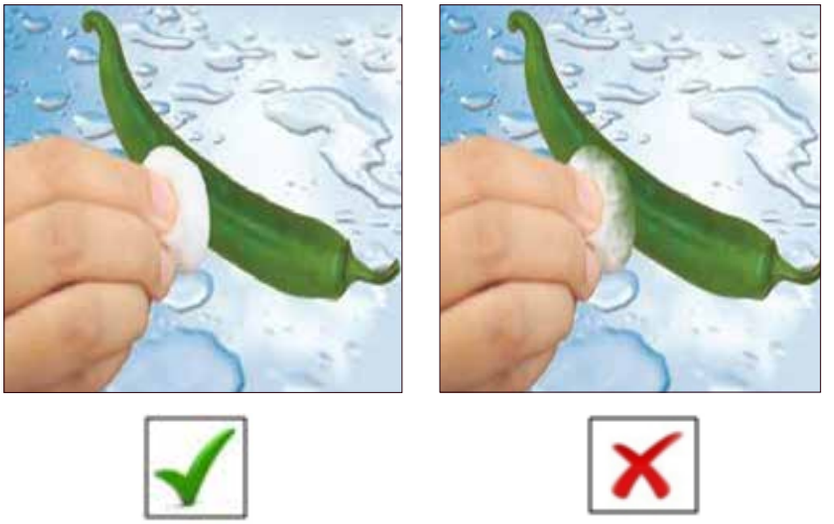
- Caramel colouring (E150), made from caramelized sugar, used in cola products and also in cosmetics.
- Annatto (E160b), a reddish-orange dye made from the seed of the Achieve
- A green dye made from chlorella algae (chlorophyll, E140)
- Cochineal (E120), a red dye derived from the cochineal insect, *Dactylopius coccus*
- Betanin extracted from beets
- Turmeric (curcuminoids, E100)
- Saffron (carotenoids, E160a)
- Paprika (E160c)
- Elderberry juice

To ensure reproducibility, the coloured components of these substances are often provided in highly purified form, and for increased stability and convenience, they can be formulated in suitable carrier materials (solid and liquids). According to the application a suitable natural colour can be achieved by keeping in mind the factors such as pH, heat, light storage and the other ingredients of the formula or recipe. The storage conditions for natural colours depend on the particular need of the product. A tight sealed container is best to store the product in a cool storage to preserve colour strength and quality, along with its degree of cooling point. Here is a list of few natural food colours:-

ANNATTO

Annatto is produced from the reddish pulp which surrounds the seed of the achiote (*Bixaorellana L.*). It is used in many cheeses (e.g., Cheddar, Red Leicester, andBrie), margarine, butter, rice, smoked fish, and custard powder. Annatto is commonly found in Latin America and Caribbean cuisines as both a colouring agent and for flavouring.As a food additive, annatto has the E number E160b. The fat soluble part of the crude extract is called bixin, the water soluble part is called norbixin, and both

TURMERIC POWDER



GREEN CHILLI

share the same E number as annatto.In the United States, annatto extract is listed as a colour additive "exempt from certification" and is commonly considered to be a natural colour.Annatto has been linked with many cases of food-related allergies, and is the only natural food colouring believed to cause as many allergic-type reactions as artificial food colouring.

BETANIN

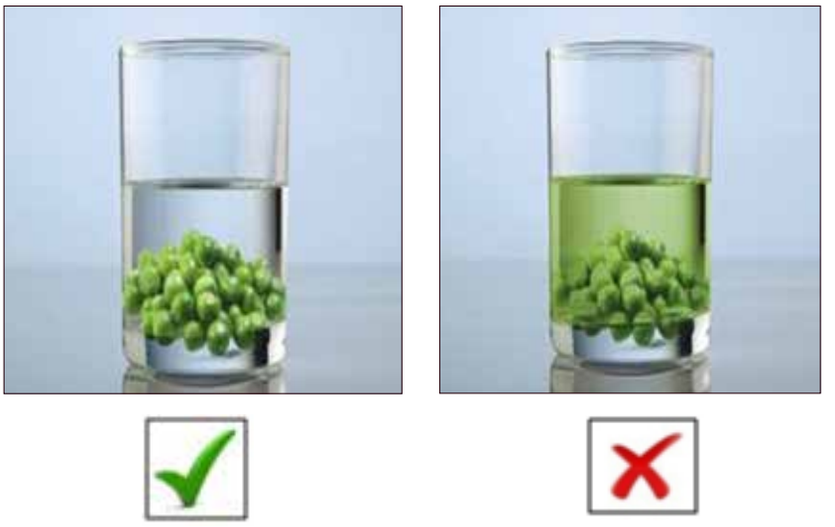
Betanin, or Beetroot Red, is a red glycosidic food dyeobtained from beets; its a glycone,obtained by hydrolysing away the glucose molecule, is betanidin. As a food additive, its E number is E162. Betanin degrades when subjected to light, heat, and oxygen; there fore, it is used in frozen products, products with short shelf life, or products sold in dry state. Betanin is usually obtained from the extract of beet juice; the concentration of betanin in redbeet can reach 300-600 mg/ kg.

CARAMEL

Caramel colour (150/ E150) is a dark, rather bitter-tasting liquid, the highly concentrated product of near total caramelization that is bottled for commercial and industrial use. Beverages such as cola use caramel colouring, and it is also used as food colouring.Caramel colour or caramel colouring is a soluble food colouring. It is made by a carefully controlled heat treatment of carbohydrates, generally in the presence of acids, alkalis, or salts, in a process called caramelization. It is more fully oxidized than caramel candy and has an odour of burnt sugar and a somewhat bitter taste. Its colour ranges from pale yellow to amberto dark brown.

CAROTENE

The term carotene is used for several related hydrocarbon substances having the formula $C_{40}Hx$, which are synthesized by plants but cannot be made by animals. Carotene is an orange photosynthetic pigment important for photosynthesis. Carotenes are all coloured to the human eye. They are responsible for the orange colour of the carrot, for which this class of chemicals is named and for the colours of many other fruits and vegetables (for example, sweet



GREEN PEA

potatoes and orange cantaloupe melon). Carotenes are also responsible for the orange (but not all of the yellow) colours in dry foliage. They also (in lower concentrations) impart the yellow colouration to milk-fat and butter.

CURCUMIN

It is the principal curcuminoid of the popular Indian spice turmeric, which is a member of the ginger family (Zingiberaceae). Turmeric(coded as E100 when used as a food additive) is used to protect food products from sunlight. The oleoresin is used for oil-containing products. The curcumin/ polysorbate solution or curcumin powder dissolved in alcohol is used for water-containing products.

ANTHOCYANIN

Anthocyanins (from Greek: (anthos) = flower + (kyanos) = blue) are water-soluble vacuolar pigments that may appear red, purple, or blue according to pH.Plants rich in anthocyanins are Vaccinium species, such as blueberry, cranberry and bilberry, Rubus berries including black rasp berry, red raspberry and blackberry, blackcurrant, cherry, eggplant peel, black rice.

PAPRIKA

Paprika is a spice made from the grinding of dried fruits of *Capsicum annuum*(e.g., bellpeppers or chili peppers). In many European languages, the word paprika refers to bell peppers themselves.Paprika is used as an ingredient in a broad variety of dishes throughout the world. Paprika is principally used to season and colour rice, stews, and soups, such as goulash, and in the preparation of Sausages as an ingredient that is mixed with meats and other spices. Paprika was first produced in Spain, as that country was also responsible for the introduction of the bell pepper into Europe. The highest quality paprika and most expensive paprika come from Spain.

COCHINEAL DYE

Cochineal is a scale insect (*Dactylopius coccus*), the female cochineal insects were dried to about 30% of their original body weight and then ground to extract colour. It takes about 80,000 to 100,000 insects to make one kilogram of cochineal dye.

RESTRICTED FOOD COLOURS

These are the food colours permitted only for external application on food products and are not allowed for internal consumption as they will turn toxic when come in contact with saliva.

There are two artificial dyes that are only approved for external food colouring,

- **Orange B** – colouring that is only allowed in the casings of hot dogs and sausages
- **Citrus Red Number 2** – is only allowed for colouring the skins of oranges

Since consumers prefer oranges which are attractive uniform yellow in colour, but in tropical condition oranges will ripe before full yellow colour development as a results their preference in market will decrease. In order to overcome this ethylene treatment was done but in orchards of Florida, USA, they use this Citrus Red Number 2 dye for colouring oranges externally there by giving them uniform yellow colour.

SYNTHETIC FOOD COLOURS

Synthetic Food Colours also known as Artificial Food Colours are manufactured chemically and are the most commonly used dyes in the food, pharmaceutical and cosmetic industries. Seven dyes were initially approved under the Pure Food and Drug Act of 1906, but several have been delisted and replacements have been found.

Current seven: In the USA, the following seven artificial colourings are permitted in food under act of 2007

- **FD&C Blue No. 1** – Brilliant Blue FCF, E133 (Blue shade)
- **FD&C Blue No. 2** – Indigotine, E132 (Dark Blue shade)
- **FD&C Green No. 3** – Fast Green FCF, E143 (Bluish green shade)
- **FD&C Red No. 40** – Allura Red AC, E129 (Red shade)
- **FD&C Red No. 3** – Erythrosine, E127 (Pink shade)
- **FD&C Yellow No. 5** – Tartrazine, E102 (Yellow shade)
- **FD&C Yellow No. 6** –

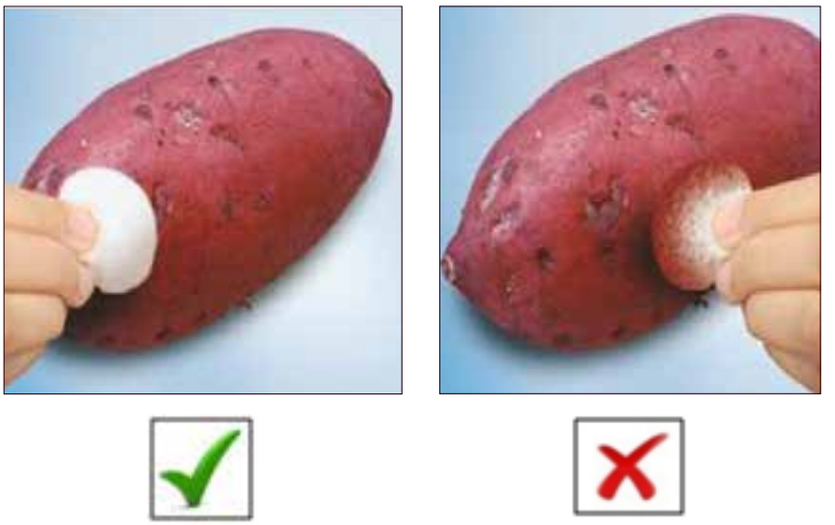
Sunset Yellow FCF, E110 (Orange shade) Delisted

- FD&C Red No. 2 – Amaranth (dye)
- FD & C Red No. 4
- FD & C Red No. 32 was used to colour Florida oranges.
- FD & C Orange No. 1 was one of the first water soluble dyes to be commercialized, andone of seven original food dyes allowed under the Pure Food and Drug Act of June 30, 1906.
- FD&C Orange No. 2 was used to colour Florida oranges.
- FD & C Yellows No. 1, 2, 3, and 4
- FD & C Violet No. 1

METHODS TO DETECT ARTIFICIAL COLOUR

Chilli powder is usually adulterated with red oxide and Rhodamine B to impart dark red colour. Turmeric powder is usually dyed with Metaline yellow or yellow soap stone powder. It can be detected by dissolving a spoon of chilli powder and turmeric powder in separate glass of water, if it is artificially coloured it will leave colour immediately into water.

In green pea and green chilli melachite green an industrial dye is used to impart green colour. In sweet potato Rhodamine B is used to colour it to make it attractive. In both coloured green chilli and sweet potato the dye can be detected by rubbing the cotton which was dipped in water or vegetable oil on the surface. If it is coloured, the colour will be seen in cotton.



SWEET POTATO

CONCLUSION

Since use of artificial colours has already been deep rooted in the society, now it is not possible to eliminate its usage by one or two of us. So being consumers we must be aware of harmful effects of these synthetic colours and avoid their consumption as much as possible.

For that first thing we must do while buying any confectionary, sweets or any other processed coloured food from a registered company they will clearly indicate in its label regarding any usage of artificial colour and its dangerous effect, so avoid such foods. Avoid or reduce giving coloured foods to children as their immune system will be weak and they are having more carving towards colourful bakery foods, candy, juices, etc, as they are attractive. Try to make colourful food in home to please your children by using different combination of different coloured fruits and vegetables and instead of going toward artificial colours use colours of natural origin during food preparation.

The risk of using additives is that after adding them to food products they become part of them. All the additives sold and used in products have passed a licensing process, nevertheless, we still hear about substances that are harmful to our health. Several novel studies suggest that sweetener consumption may be followed by increased food intake and can cause overweight or obesity, while other studies refute the decreased or unchanged ratings of hunger or food intake. As a result of consumers' negative feelings towards artificial sweeteners the demand for stevia, a natural non-caloric sweetener seems to be rapidly increasing.From the toxicological point of view sweeteners are the most examined and most controversial additives in the food industry.

Chinese or Country Potato
The good potato

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Coleus (*Plectranthus rotundifolius Syn. Solenostemon rotundifolius, Coleus rotundifolius, Plectranthus tuberosus, Coleus parviflorus*) also known as Chinese Potato belongs to the family Labiatae of order Lamiales with a chromosome number of 2n= 64. It is very well known as the Chinese potato—but it's neither Chinese nor a potato. Chinese potato is widely cultivated as an ornamental plant and an important minor tuber crop with tremendous potential for utilization in food, feed, and industrial sectors. The Chinese potato tubers are smaller in size with unique taste and aroma.

Importance

The crop is a vital food source during the lean periods for both rural and urban communities in most parts of Africa, Sri Lanka, and South-east Asia (Tavva & Ramanathan, 2007). The tubers of Chinese potato are consumed on a regular basis in the main meal or as a snack item in Ghana (Sugri et al., 2013). Boiled Chinese potato tubers are popular among Ghanaians and are consumed alone or

Fig.1 Chinese potato in field

eaten with salt and pepper with or without groundnuts. In addition, boiled Chinese potato is highly preferred with a special soup prepared from millets and groundnuts in Ghana (Sugri et al., 2013). Furthermore, Chinese potato tubers are parboiled and sundried to extend their shelf life. These parboiled tubers are combined with beans for the preparation of main meals in Ghana. In India especially in Tamil Nadu and Kerala, Chinese potato tubers are treated as a delicacy among vegetables due to their unique aromatic flavor (Tavva & Ramanathan, 2007). In Kerala, the crop is grown in lowlands of Thrissur, Palakkad and Malappuram districts.

One Potato many names

Chinese potato is also known as Hausa potato, Frafra potato, Fabirama, Innala, or country potato. Some local names include Hausa potato (Ghana), Innala (Sri lanka); Kembili (Mali.); Ketang (Indonesia.); Koorka (India.); Madagascar potato (France.); Ratala (Srilanka.); Saluga (Nigeria.); Sudan potato, Tumuku (Niger.); Vatke (Ethiopia.). In India, it is known by several names such as Koorka in Malayalam, siru kizhangu in Tamil, sambrani gadde in Kannada and kook in Konkani.

Origin and Distribution

Chinese potato is considered to have originated from East Africa and later spread to tropical West Africa and Southeast Asia. In Asia, the Chinese potato is reported to be cultivated in Sri Lanka, South India, Malaysia, and Indonesia. It grows over a wide range of climatic and edaphic conditions. The optimum temperature for growth and development ranges from 25-30° C. It grows well in grassland and at elevations up

to 2,200 meters.

Botany

Chinese Potato is an aromatic, semi-succulent perennial herbaceous plant that normally grows up to 1 m tall. The plant cannot stand water logging and prefers a well-drained sandy loam but can tolerate a range of soils and heavy clays are unsuitable. It is a herb with a prostrate or ascending habit and a succulent stem reaching up to 15-30 cm in length, forming tubers in clusters around the base of the stem. The tubers are small and dark brown. The stem is decumbent or ascending, quadrangular, with densely pubescent on the angles and roots at the nodes. The plant produces egg-shaped, potato-like tubers usually 2–4cm long, occasionally to 8 cm, occurring in clusters of 3 – 7 at the base of the stem. They are blackish, brownish, reddish-grey, or whitish, with rough skin.

Fig. 2 Chinese potato tubers and Inflorescence

The leaves are rather thick, juicy, and faintly aromatic when bruised and arranged oppositely. The inflorescence is a terminal false spike, measuring 5-15 cm long, with distant whorls of 4- 6 flowers. The flower is tubular and 2- lipped, measuring 7-12 mm long, light to dark violet, velvety and gland-dotted.

Nutritional composition

Chinese potato tubers are considered as a store house of all essential nutrients for human nutrition. In this context, Joy et al. (2017) studied raw and processed tubers (boiled, roasted, and steamed) of Chinese potato for essential nutrients. The study showed raw tubers containing relatively higher levels of essential nutrients such as Ca, Fe, K, Na, Mg, and P compared to boiled, roasted, and steamed tubers. Moreover, Devi et al. (2018) studied mineral content analysis by indicating the presence of Li, Al, Cr, Mn, Fe, Ni, Co, Cu, Zn, Ga, As, Se, Sr, Ag, Ba, Na, K and Ca in P. rotundifolius tubers. Sethuraman et al. (2020) reported the presence of higher mineral (Ca, Fe, K, Na, P, Mn) content in tubers compared to popular tuber crops such as potato, sweet potato, and cassava. Hence consuming Chinese potato tubers could help to meet the nutrient recommendations for male and female aged between 31 to 50 as per the American Dietary guidelines. Furthermore, Nkansah (2004) reported the presence of water (75.6 g), protein (1.3 g), fat 0.2 g, carbohydrate (21.9 g), fiber (1.1 g), calcium (17 mg), iron (6.0 mg), thiamin (0.05 mg), riboflavin (0.02 mg), niacin (1.0 mg) and ascorbic acid (1 mg) per 100 g edible portion of raw tuber with a total energy of 394 kJ (94 kcal),. Additionally, according to PROTA (2013), 100 g of the raw tubers contain water (76%), carbohydrate (21%), protein (1.4%), fiber (0.7%), fat (0.2%), and ash (1.0%) amongst other important nutrients. Moreover, Eleazu et al. (2016) demonstrated the intermediate glycaemic indices of 60.07 to 62.49 g/100g in raw and processed (boiled and fried) tubers of Chinese potato. In addition, starch digestibility in Chinese potato raw and processed tubers are highly influenced by the presence of digestible and rapidly digestible starch (Eleazu et al., 2016).

Medicinal properties

Chinese potato has great medicinal importance and is used for treating several ailments and infections. It is widely used for treating stomach disorders, vomiting, diarrhoea, mouth and throat infection, abdominal pain, wounds, burns, insect bites, and other sensory disorders. It can also improve immunity and the body's defence mechanism. The bioactive compounds contributing to these medicinal properties include biologically active mono- and sesquiterpenoids found in the tubers of the Plectranthus species. In addition to the essential nutrients, Chinese potato tubers are good sources of various antioxidant compounds exhibiting antioxidant properties. Bioactive compounds such as phenolics, tannins, and flavonoids are reported in raw (244.10 mg of TAE/g, 204 mg of TAE/g, 65.76 mg of RUE/g) as well as processed Chinese potato tubers [boiled (229.41 mg of TAE/g, 189 mg of TAE/g, 61 mg of RUE/g), roasted (223.13 mg of TAE/g, 173 mg of TAE/g, 62 mg of RUE/g), and steamed (225.52 mg of TAE/g, 172 mg of TAE/g, 64 mg of RUE/g)] (Joy et al. 2017). The antioxidant potential of phenolics, tannins, and flavonoids present in raw, boiled, roasted, and steamed Chineses potato tubers were studied using ABTS, DPPH, FRAP, and metal chelating antioxidant-based assays. Antioxidant properties of raw, boiled, roasted, and steamed Chinese potato tubers were found on par with yam tubers in the study (Joy et al. 2017). These antioxidant properties are strongly supported by the presence of antioxidant enzymes such as superoxide dismutase (0.0651±0.06 units/mg protein), catalase (0.167±0.16 units/mg protein), glutathione peroxidase (31.97±0.05 units/mg protein) and glutathione S transferase (19.68±0.10 units/mg protein) (Devi et al., 2018). Furthermore diversified phytochemicals were identified in methanolic extracts of

Chinese potato tubers which include alcohols, Phenols, Amines, alkanes, aldehydes, carboxylic acid, iso cyanides, alkyne, isocyanate, ketones, aromatics, phenols, tertiary and primary alcohols and Chloro compounds (Manikandan et al., 2016). Cis-Vaccenic acid was identified as a major active phyto component present in methanolic extracts of Chinese potato tubers (Manikandan et al., 2016). Chinese potato tubers with significant antioxidant and antidiabetic properties (medium glycemic indices) can offer therapeutic dietary solutions to fight off non-communicable disease development.

Chinese potato Varieties in India

Sree Dhara: Sree Dhara was released by ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI) in 1993. The average yield is 25tha-1 and the starch content is 19.5%. The duration of this variety is 4-5 months.

CO-1: This variety was developed by Tamil Nadu Agricultural University Coimbatore and released during the year 1991. It is a clonal selection from Periyakulam local. The variety yields 32.89 percent increased yield over local type with 0.40 percent forskohlin.

Suphala: Suphala is a photo-insensitive variety released from Kerala Agricultural University with an average yield of 15.93 t ha-1 and duration of 120-140 days.

Nidhi: a selection released in 2000 by Kerala Agricultural University

K8: Released from IIHR, Bangalore and selection from Karnataka. It gives 0.5% of forskolin and a higher tuber yield Aisiri (Mutant-7): Higher tuber and forskolin yielding variety developed and released by the University of Agricultural Science, Bangalore. Matures in 180- 200 days and gives a dry tuber yield of 7000 – 7500 kg/ha with a forskolin content of 0.76%.

Manganiperu : It is cultivated in and around Belgaum districts of Karnataka. The tubers are big, 30.00cm length. It is also commercially cultivated in Tamil Nadu.

Garmai and Maimul: It is cultivated in Gujarat state. The tubers are of medium size.

Conclusion

The overall interventions to achieve household food security should not be limited to only few major staples crops. Instead, various traditional and underutilized crop species need to be included in local and national agricultural food policies and programmes. Systematic interventions through development of high yielding varieties, improving agronomic practices, enhancing value addition technologies, better access to markets must be developed and extended to the farming community to improve the utilization of this versatile crop.

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CASSAVA LEAVES AS HUMAN NUTRITION

Potential and limitations

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Cassava is grown mainly for its tubers whereas leaves are mostly considered as a by product. Cassava leaves are a rich source of protein, minerals, and vitamins. The potential yield of cassava leaves varies greatly based on cultivars, plant age, plant density, soil fertility, harvesting frequency, and climate. However, the presence of anti-nutrients and cyanogenic glucosides is the major drawbacks in cassava leaves that limit its human consumption. Toxicity caused by cyanogenic glucosides and anti-nutritional factors such as high fibre content, tannins, polyphenols, and phytic acid, which reduce nutrient bioavailability, absorption, and digestion. Anti-nutrient levels vary according on cassava

maturity, climate, and variety. Cassava leaves are consumed both fresh and cooked in various parts of the world depending on taste preferences, economic situation, and the availability of other food crops. Cassava leaves are an important part of the diet in some African countries, but they are not extensively consumed in many countries, despite the fact that cassava is widely grown and readily available. Cassava leaves are consumed as a vegetable in at least 60% of Sub-Saharan African countries and certain Asian countries such as Indonesia, the Philippines, and Malaysia. Cassava is grown not just for its tubers, but also for its leaves, which are used as a vegetable in Tanzania, Kenya, Malawi, and Madagascar countries. It is a better source of protein and nutrients for human nutrition than the tubers, which are deficient in protein. Cassava leaves constitute more than 60 % of all vegetables consumed in Congo.

Cassava leaves are considered a poor man's food in some countries and are only eaten when other vegetable leaves are unavailable or during food shortage, while in other countries they are not consumed at all. Cassava leaves have low digestibility, which could be due to their high fibre content, tannins, and low amino acid availability. If lignin is properly removed, cassava leaves can be used as food and feed. Consumption of improperly processed cassava leaves may result in a variety of diseases.

DETOXIFICATION

Cassava leaves have a cyanogenic potential that is 5 to 20 times greater than tubers. Cassava leaves are considered highly poisonous since they contain more than 100 ppm of total cyanide content on fresh weight basis. High cyanide exposure also aggravates iodine deficiency and causes goitre. Before being consumed, the leaves must be detoxified to less than 10 ppm, a safe limit established by the World Health Organisation

(FAO/WHO, 1995). Young leaves have the highest level of linamarin, which reduces to 50-70% in mature leaves, while yellow leaves contain insignificant amounts. The bitter taste of cyanogenic glucosides acts as a feeding deterrent and is used to distinguish between bitter and sweet cassava. Cyanogens are removed by the enzyme linamarase, which is abundant in cassava leaves. Cassava leaves that have been detoxified could be used as a safe nutrient source.

Several traditional processing approaches have been established to minimise cyanogenic glucosides, however each method has inherent drawbacks. Traditional processing techniques such as pounding followed by boiling reduce the cyanide content of cassava leaves to very low levels. According to Bradbury and Denton (2011), pounding for 10 min followed by two washings at room temperature with double the amount of water can remove 92% of total cyanide. Bradbury and Denton (2014) found that three consecutive processes of pounding, standing for 2 hours in the sun or 5 hours in the shade in the tropics, and three times washing with water can reduce total cyanide level to 72%, 88 %, and 99 %, respectively. Sun drying alone removes 90% of the hydrogen cyanide (HCN) and can be supplemented with chopping and wilting to increase the efficacy of this method. The most effective way for removing cyanogenic glucosides is to pound the leaves and then boil or dry them. Consumption of detoxified cassava leaves can improve malnutrition caused by protein deficiency in the cassava tuber dependent society. In addition to being a source of food, detoxified cassava leaves can also be used as a source of feed, providing additional animal protein.

CASSAVA LEAF PROTEIN CONCENTRATE (CLPC)

Leaf protein is a rich source of amino acids, with methionine being a limiting factor. Cassava leaves have an average yield of 10 tonnes per hectare and a good source of protein, better than tropical legumes. Cassava leaves have a high crude protein content of 4.0–9.6% fresh weight basis and 17.7 – 38.1 % dry basis. Cassava leaf protein concentrate (CLPC) deficient in methionine is not considered as a single protein supplement for diets based on cassava. High levels of chlorophyll and xanthophylls, high fibre and cyanide content in cassava leaves are limiting their use as a major protein source. Several attempts have been made for protein extraction, none of them have received industry adoption due to various limitations. Cassava leaf protein extraction with simultaneous detoxification and nutrition retention may be a promising option for efficiently using protein and nutrient-rich cassava leaves.

CONCLUSION

Cassava leaves are an important part of the diets of millions of people living in cassava growing countries. It is also critical to emphasize the potential of cassava leaves and to encourage their usage by reeducating people to view them as a beneficial supplement to the diet rather than as a food linked with poverty.

Nutrient retention and bioavailability in processed cassava leaves, as well as the efficacy of cyanogens removal by different methods of processing, must be established; also, more research on the nutritional aspects of cassava leaves is required.

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STUCK FERMENTATION A SLUGGISH ALCOHOLIC FERMENTATION

Despite many improvements in winemaking processes, such as the control of oxygen concentration and temperature, the use of selected yeasts and the correction of nutrient deficiencies, stuck fermentations remain a major problem in wine fermentation world wide, generating considerable losses within the wine industry. "A stuck fermentation is one in which fermentation has ceased prematurely or the rate of fermentation is considered too low for practical purposes, leaving a higher residual sugar content than desired in the wines at the end of the fermentation. Not only it delays the completion of the alcoholic fermentation,

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but it can also lead to off-aromas formation. A residual sugar concentration of less than 2g/L is considered dry or completed by winemakers.

Stuck fermentations directly decrease productivity and may reduce wine quality. Indeed, the resulting wines, which contain various amounts of residual sugar, are microbiologically unstable. The major risk is the use of this excess sugar by lacticacid bacteria to generate acetic acid. This organoleptic spoiling can be prevented by adding SO_2 (2 to 3 g/hL) and restarting the fermentation with a special restart procedure. Various treatments of the stuck wine before the restarting procedure have been recommended, including the use of yeast hulls to remove inhibitory compounds, such as fatty acids and alcohol removal techniques. Many restart procedures have been developed by yeast manufacturers and cooperative institutes. These procedures follow the same essential framework, although the precise details vary. Basically, a new yeast starter is prepared from dried selected yeast and progressively allowed to acclimate to the stuck wine.The number and duration of acclimation stages may differ between restart procedures (Maisonnave et al., 2013).

Factors leading to a stuck fermentation

Glucose/Fructose ratio

Saccharomyces cerevisiae is a glucophilic yeast, preferring glucose to fructose. Some yeast are more fructophilic than others. During fermentation, glucose is consumed at a higher rate than fructose and the proportion of fructose increases as fermentation progresses. This can lead to imbalances in the wines and under the stressful conditions found at the end of fermentation, make it more difficult for wine yeast to utilize this non-preferred sugar.

Nitrogen deficiency

Nitrogen is the most important yeast nutrient and has a significant impact on wine fermentation. It influences both fermentation kinetics and wine profile. The minimum quantity of yeast assimilable nitrogen (YAN) in must is 150 to 200 mg/L and lower levels are considered as nitrogen deficient. When the MUST(Must is the name given to the freshly pressed grape juice, containing the skins, stems and stems of the grapes. Must is the first step in winemaking after the grapes have been harvested from the vine) is deficient in nitrogen, it will limit the yeast growth

and fermentation speed. YAN content has the most influence on the fermentation speed; it impacts the yeast biomass at the beginning of fermentation, as well as the sugar transport kinetics during fermentation (Ducet al., 2019).

Lack of oxygen and the role of sterols

Oxygen plays an essential role in alcoholic fermentation helping the development of an adequate yeast population and maintaining their vitality. Oxygen is required for the synthesis of survival factors such as sterols and unsaturated fatty acids, which are components of the yeast cell membrane. They play a key role on the membrane structure helping to maintain the membrane fluidity, cell integrity and viability.

Improper yeast rehydration and handling

Proper yeast rehydration is a key in successful alcoholic fermentation (AF) as it is a crucial phase for the survival and efficiency of the wine yeast. If the yeast is not properly rehydrated, more than half of the yeasts population can die. It is very important that manufacturer's instructions be followed particularly with respect to the dosage, the medium and temperature used for rehydration. During yeast rehydration, the active dry yeast will absorb water and recover their original form. The organs inside the cell continue rehydrating and a part of them disperse in the rehydration water. This loss can represent between 20-30 % of the dry weight of the yeast and can result in a micronutrient deficit.

Lack of temperature management

Temperature will affect AF when it is the extreme, either too low or too high, since it has been shown that ethanol toxicity increases at extreme temperature. The yeast cell membrane is weakened and eventually leads to cell death.

Inhibitory metabolites

Grape MUST composition may have inhibiting toxic compounds that affect yeast viability and fermentative activity and that are responsible for sluggish or stuck alcoholic fermentation. Inhibiting toxic compounds, such as short and medium chain fatty acids (SMCFA)

have been widely described for their inhibition of alcoholic fermentation. Pesticide residues (fungicide, herbicide, insecticide) can also seriously affect yeast viability and compromise the end of fermentation. Recent studies also showed that they can negatively impact the production of aromas (namely esters) and the wine's fruit character.

Nutritional imbalance

Nutritional imbalance is different than nitrogen deficiency, as having lower YAN levels is a factor that in itself, does not explain everything. Indeed, well-balance nutrition (including minerals, vitamins, sterols, organic nitrogen) is the optimal key to assure yeast viability as well as optimize the yeast aroma biosynthesis and release. New results have shown that even if the YAN is high, starvation of oleic acid, ergosterol and pantothenate as well as nicotinic acid, will lead to loss in viability for the yeast and eventually death resulting instuck fermentation and overproduction of H_2S. When choosing a nutrient, quality is as important as quantity since only organic nutrients will provide those optimal growth factors as well as nitrogen and have a better nutritional balance than with only chemical DAP.

Vitamins and minerals

Minerals serve as

- Cofactors of several glycolytic enzymes
- Increase ATPase activity and the pumping of the compounds across the yeast membrane
- Increase yeast's tolerance to ethanol and temperature
- Antagonistic effect on the toxicity of heavy metals
- Regulation of cellular growth
- Regulation of the formation of alcohol and esters

Vitamins are organic compounds essential for the optimum growth of yeasts cells and for their capacity to survive under stressful conditions. The majority act as enzymatic cofactors. They can also intervene in energy transfers or in supporting membrane integrity (Julienet al., 2017).

Prevention of stuck fermentation

There are various techniques that a winemaker can employ to minimize the chances of a stuck fermentation happening. The most common is to use a cultured yeast strain with high alcohol and high temperature tolerance coupled by diligent control of the fermentation temperature. Another technique is to add yeast nutrients like nitrogen to the MUST. The ammonium salt diammonium phosphate or yeast nutrient, is a popular inexpensive means of ensuring the MUST has sufficient nitrogen. Whatever technique the winemaker uses, each has the potential to subtly or drastically affect the resulting flavour and quality of the wine.

- Monitor and ensure proper fermentation

temperature

- Ensure proper sanitation
- Use fresh yeast
- Use the proper yeast
- Properly rehydrate yeast before pitching
- Pitch the yeast within 20 minutes of rehydrating it
- Maintain proper free SO_2 levels
- Add yeast nutrient before pitching yeast
- Aerate the must properly

How to restart

- Bring MUST upto proper temperature, typically 70-80°F depending on your yeast
- Aerate it by stirring the must, the yeast needs oxygen to work properly
- Before re-pitching yeast, add additional yeast nutrients to the must
- If the prior three methods fail, re-pitch your yeast

For wines stuck at >3°B

- Add 40g/hL of RESKUE 24-48 hours prior to restarting
- After 24-48 hours, rack off from the RESKUE is the yeast cell wall product
- Add a complex yeast nutrient directly to the tank of stuck wine at the rate of 6-12g/hL
- In another clean container mix equal volumes of stuck wine and water (2% of the total wine volume)
- Dissolve the yeast rehydration nutrient in 20 times its weight of clean, chlorine free, 43°C water
- Mix the solution and cool to 40°C
- Select a yeast strain that is both alcohol tolerant and vigorous fermenter
- Add it to the rehydration nutrient/ water solution at the rate of 36-60g/hL
- Check the temperature of the yeast suspension and the wine in mother restart tank
- Add the yeast to the mother restart rank and wait for 20-30 minutes

Inoculation of stuck wine

Step1: Add 10% of stuck wine to the mother restart tank and wait for 20-30 minutes

Step2: Add 20% of stuck wine to the mother restart tank and wait for 20-30 minutes

Repeat step 2, three or more times until you have added approximately 90% of the stuck wine. Add any remaining wine to the mother restart tank.

For wines stuck at 1-2°B: follow the same protocol, except in step 3 reduce the complex yeast nutrient addition to 6g/hL.

For wines stuck at < 1°B: follow the same protocol , except in step 3 eliminate the addition of a complex yeast nutrient.

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