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KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

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Solutions for smart farming

INSIDE

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Buddha's hand or Fingered citron: An ornamental Citrus sp

Buddha's hand or Fingered citron (Citrus medica var. Sarcodactylis) is a unique citron cultivar which is considered as a progenitor of many Citrus sp. Fingered citron is native to NorthEastern India and was carried into China by Buddhist monks around the 4th century. Fingered citron has been cultivated for at least 1,000 years in Southern China and Japan. It has been grown in some parts of Kerala as an ornamental crop.

Uses

Besides its unusual appearance, the fruit of Fingered Citron makes excellent zest. The very fragrant mature rind gives

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an excellent aroma and lacks the bitterness commonly found in lemon and orange peels. This citrus fruit makes a great alternative in recipes calling for lemon or orange zest. The zest can also be diced and cooked in sugar water to make candied fruit, a tasty snack.

Essential oils in fingered citron play an important role against bacteria. The oils are rich in esters and ethanol and can inhibit the growth of *Escherichia coli*.

For research:

`From a plant health standpoint, fingered citron exhibits natural resistance to citrus canker *(Xanthomonascitri subsp. citri)*, which suggests a potential use in future canker-resistance breeding programs

Plant habit:

Like the common citron, fingered citron grows on small evergreen trees or shrubs that reach six feet tall. The alternately arranged leaves have

an oblong shape with serrate margins. Newly grown leaves, fragrant flowers and fruit often appear purple, pink and green, respectively. The hand like fruit shape may display either open fingers or a closed fist. Like other citrus varieties, fingered citron fruit is a hesperidium, a specialized berry with a thick, leathery rind. Flavedo, the outer colored part of the rind, turns yellow and becomes extremely fragrant during maturation. Fruit size ranges from four to eight inches long. Although the fruit can be lengthy, juicy pulp underneath the flavedo is often absent.

Instead there is a thick but spongy albedo (the inner, white part of the rind), which is not edible.

Propagation:

This species can be propagated through seed, stem cuttings or leaf cuttings. It should be cultivated in moist, well-draining soil and with maximum sunlight availability. When grown in a large container, it grows up to 0.3 to 0.9 m tall.

Health benefits:

Relieves pain
Treats respiratory diseases
Boosts immunity
Benefits the gastrointestinal system
Regulates blood pressure
Relief to menstrual pain, mood swings and cramps.
Lowers cholesterol

The presence of phytochemicals, such as xanthyletin and nordentatin, in the root and stem barks of fingered citron also show anti-inflammatory effect. Fingered citron fruits can boost secretion of insulin to fight against type 2 diabetes.

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Kerala is bestowed with diverse agroecosystems that sustain and flourish under the southwest monsoon. The backwaters of Kerala are known worldwide for their pristine beauty and abundance of biodiversity. While effective crop cultivation in the coastal belts of Kerala is considered impossible by human logic, Kaippad and its associated marine ecosystems stand as an example of how nature can make impossible possible

THE LAND OF SINGULARITY
THE KAIPPADS OF KERALA

Kaippad is a region in the Kannur district of Kerala, which is part of 580 Km long coastline owned by Kerala. The area remains waterlogged during monsoon and saline during summer due to the intrusion of sea water owing to the effect of high and low tides. Kaippad region is mainly of marshes, swamps, ponds and paddy fields. The most well-known is its indigenous and organic rice cultivation, using traditional varieties unique to this region.

All agricultural operations in this region start by April with drying of the fields and controlling further tidal water intrusion by way of bunds constructed around the field. The bunds are known colloquially as chira or kandy. Water is a main problem which is regulated by way of sluices known as Mancha. Rice cultivation is undertaken only from April to October, and rest of the year, fish farming is practiced. The varieties used are usually named locally, for example Chovverian, Kuthiru, Kuttusan, Orkazhama and Orthadian which are known for their remarkable capacity to tolerate salinity. These varieties are not only salt tolerant but also submergence tolerant.

After about one month of field draining, pre-germinated seedlings are planted in mounds also called "potta" colloquially. Mounds are taken with the intention of leaching salt from soil by incipient rain. Usually 7 day old seedlings are planted on top of mounds. The mounds are flattened after 45 days of planting Other cultural operations usually followed in rice cultivation are not followed in this system except occasional removal of weeds. Fertilizer application is completely avoided as the soils are rich in nutrients. This nutrient enrichment of soil happens due to tidal incursion of saline nutrient rich sediments. By the end of October, the rice would be ready for harvest, and the panicles alone are cut leaving the rest of the stubbles to remain in the field. The stubbles decay with time and get incorporated in the field.

The decaying stubbles form feed for prawns that are raised in the upcoming season. November to April is devoted to fish farming which is generally the high salinity phase. Sluices are kept open for tidal water and fish to enter the field. Once fish reaches maturity, nets are kept near the sluices to catch them. All wastes generated as a result of fish farming is ultimately added to the soil for raising the next season's crop.

As nations are embracing a rapidly changing world at their own pace, disasters, climate change and food security issues affecting every aspect of day-to-day life, studies on crops that can change the dynamics of food production need our attention and Kaippad for sure would rank first for attention.

Strategies to enhance livelihood of tuber crops farmers

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Livelihood assessment in Karnataka

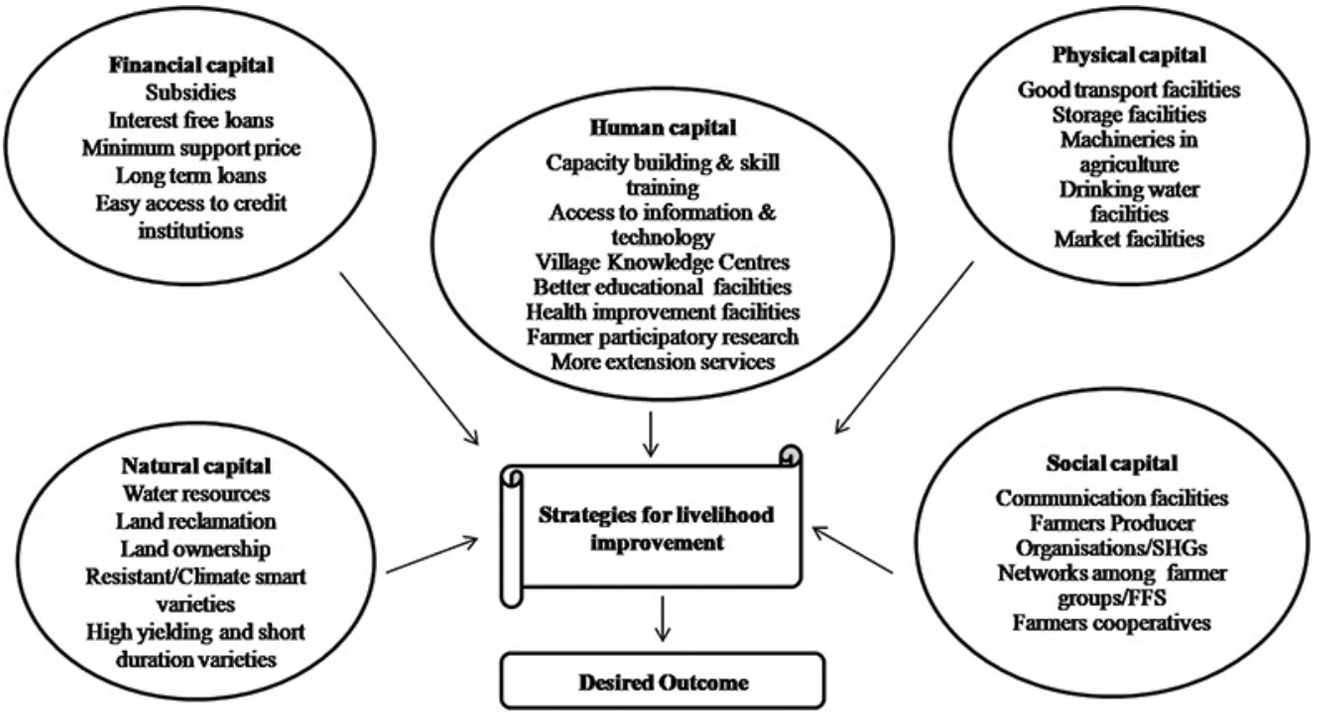
Introduction

Tuber crops are the third most important crops grown in the tropical regions in the world. Tuber crop plants yield starchy roots, tubers, rhizomes, corms, and stems. Tuber crops are more climate resilient in the agricultural ecosystems and hence they may certainly contribute to the future stability of food security. They play a significant role in the food security of people especially the marginalised and the tribes. They cover their nutritional security as well as address the malnutrition among the farming community. In addition to this, it also provides employment, livelihood and income to the poor farmers. These types of crops come up in less fertile soil with limited inputs and these are commonly termed as poor man's crop and also as a saviour crop. In some parts of the country, crops such as cassava, sweet potato, yams, and elephant foot yam are consumed as vegetables. They are used as food and either taken directly or in processed form. They are also used as animal feed, and for manufacturing starch, industrial products and in textile and pharmaceutical industries. In most of the developing countries, poor households depend upon tuber crops as an important source of food and nutrition. In India, it is mostly grown in Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Odisha and states where tropical climate prevails. Tuber crops provide livelihood to the farmers in the country to a greater extent. Tuber crops are also grown as intercrop in coconut gardens with other crops. Most of the farmers grow cassava, sweet potato, yams and elephant foot yam in their farms and earn their livelihood.

What are livelihoods?

Livelihood refers to the means of securing the basic necessities such as food, water, shelter and clothing. It also includes the set of activities

Livelihood assessment in Kerala



Source: Jaganathan et al. 2020

considered to be necessary for day to day life over one's entire life. Such activities include securing water, air, food, fodder, medicine, clothing and shelter. An individual's livelihood involves the capacity to acquire the above mentioned necessities in order to satisfy the basic needs of oneself and his family. The activities are usually carried out constantly and it should be sustainable and providing them a decent and dignified life. The concept of livelihood extends to social and cultural means also. It also includes the relationship among the different strata of societies, their communication levels, social networks, legal rights, access to land, labour and capital. Livelihood studies focus on the relationship between macro and micro level processes and it includes people's active response to the rapid changes in the society. People depend on income diversification to get a stable income and this is done by most of the categories of people. They derive income through multiple sources with multiple motives. Livelihood research has shown that many people simultaneously engage in urban and rural life, work in both formal and informal sectors, or commute from one place to another on a daily basis to earn a livelihood. It is also important to explore the different capitals, gender relations, power distribution, market access, rights and legal issues, and government policies which have ample impact on the livelihoods of people.

Why livelihood interventions?

It is imperative to understand the association between different players holding different resources and power, and their cultural and historical scenarios. It is an important part of elucidating various types of livelihood, vulnerability and opportunities for making a living. The result of the livelihood studies can be used to devise interventions and to explore the possibilities of making a better living to the farmers. Livelihood interventions can be used to promote livelihoods. Livelihoods also change over time due to the changes in the social, economic and political scenario, due to the changes in policy, or because of individual and collective actions. Knowledge of the complexity and integrated nature of livelihoods help to draw better understanding of their vulnerability to external

shocks and stresses and the coping strategies adopted by the community to tide over the situation. Livelihood analysis is a complex process and while analysing the livelihood it should be focussed not only on agricultural issues but should also include the rural livelihoods more generally. The livelihood interventions help the farmers to use their available resources in a more productive way and to have a sustainable livelihood throughout.

Livelihood strategies

The study conducted on the livelihood of tuber crops farmers in Tamil Nadu, Kerala, Andhra Pradesh and Odisha on different capitals were analysed and the strategies were suggested to further improve the livelihood of tuber crops farmers in India.

B. Strategies for livelihood improvement

Source: Jaganathan et al. 2020

The strategies of livelihood improvement may be classified under five capitals namely Financial capital, natural capital, human capital, physical capital and social capital and the details are given below.

Financial capital

Financial capital index denotes the financial resources that people use to achieve their livelihood. Financial capital includes household income, credit availability, credit source, savings and debt. Financial capital is the foremost capital required to take up any employment activity. The financial position of the farmers can be improved one way by providing subsidies for capitals and other agricultural inputs so that it may enhance their financial position. Mostly farm loans are given to farmers for taking up agriculture activities and if it is interest free or with minimum interest, it may be a great support to do farm activities. Farmers source of fund may be formal or informal. In informal source the interest rate may be more and this again becomes a burden to them. If their financial capital is more, they can save for the future and this can be used during their bad times and improve their livelihood outcome. In case of financial difficulty, farmers harvest the crop before the crop attains maturity and this may force them to sell the product at a low cost. Mimimum support price will be a hand holding

Livelihood assesment in Andhra Pradesh

Livelihood assessment in Odisha

support to the farmers to get the real value for their produce. Long term loans will be reducing their immediate burden of financial constraint. Access to credit may be made easier with minimum collateral. Even financial support is given through government schemes and this can be utilised by the farmers and thus they can accumulate their money wealth.

Natural capital

Land area, ownership of land, crops grown and irrigation source form the natural capital. Availability and access to these natural capitals depend on the ability of the tuber crops farmers in accessing and utilising the resources. Irrigation source is important for raising tuber crops. Eventhough tuber crops are cultivated in rainfed condition their production and producitivity may be improved if it is raised in irrigated condition. Crop diversification is also possible if the farmers have adequate water resources. Sequential cropping of cassava followed by paddy may be adopted in areas where it is feasible to maintain the soil fertility which in turn will help in food and nutritional security. Sweet potato being a short duration crop with high yielding potential contributes significantly towards livelihood security of the growers. Tuber crops based cropping/farming system may be adopted in large scale keeping in view of the demand for the produce in domestic and international market. Sequential cropping of sweet potato followed by cereals and pulses may be adopted in suitable areas to maintain the soil fertility which may help in food and nutritional security. The knowledge of the farmers to maintain and sustain the availability of the natural capitals is directly related to their efficiency. Unutilised land may be put to use by providing financial support to the farmers. Land reclamation with a minimum support from the schemes also helps in area expansion of tuber crops. Land ownership is also an important contributor for tuber crops production.

If women are given the land ownership it empowers them to get more involved in tuber crops cultivation. Short duration, high yielding varieties, pest and disease resistant varieties are to be provided to the farmers to get better yield and income. Livelihood diversification of the available natural resources by the tuber crops farmers can help them to tide over the disasters and vulnerabilities.

Human capital

Human capital includes the educational level, training on tuber crops, labour availability, health facilities and knowledge on tuber crops cultivation. The level of knowledge possessed by the farmers will have an impact on the outcome and it help to minimise the risk and improve the production and productivity. Utilisation of family labour reduces the cost of cultivation and at the same time the income stays within the same household. Many farmers are not aware about the improved technologies in tuber crops and if they are offered training facilties it would help them to improve their knoweledge, skill and bring about a change in their attitude to cultivate and adopt the latest technologies in tuber crops. Information centres are more in urban areas than in rural areas and hence more information parks in the rural areas will provide the farmers with updated knowledge and information. Education is an important driver for social and economic development of an individual. Access to education is to be made easier to the farming community in their own village. Farmers should be given a platform to meet and interact with the technology developers so that they can get the direct information about technologies and other recent developments in tuber crops. More extension and technology transfer efforts are to be made by the line departments.

Physical capital

Physical capital includes transport facilities, type of housing, drinking water facilities, electricity, and fuel sources. Transport facilities in the villages are very important for the farmers to realise better market price. Marketing is a problem faced by farmers when there is more supply than demand. Farmers prefer to sell their produce in the local markets rather than outside markets. The rural market should be linked with urban markets for better market prices. To improve the connectivity, road and transport facilities need to be improved. Transportation cost also should be mininised to get more profit. Storage facilities need to be improved to get good market prices for the products and to store the products when there is excess production. Farmers need to be trained in value addition to realise better price and to avoid losses. To reduce post harvest lossess and to reduce drudgery agriculture tools and machineris need to be developed with low cost and more effciency. Women friendly drudgery reducing machineries need to be developed and made acessible to the women farmers. The first step to women empowerment in rural areas is to make available the drinking water facilites so that the time women spend on gathering water can be utilised productively. Market facilities and infrastructure need to be developed so that the farmers can get good access to market. Housing facilties need to be improved so that the farmers can have better living conditions.

Social capital

Social capital includes social relationship, membership in organisation, access to agriculture information, peer group communication, and communication facilities. Information and Communication Technology (ICT) can be used as a potential tool to develop the tuber crop farmers in rural areas. But farmers should be made aware about the facilities and should make use of it to the full potential. Introduction of ICT in agriculture more effectively, will ensure the dissemination of required information at the right time. Communication facilities should be improved so that the farmers in the villages get connected with the outside world. Even the communication technologies can provide weather information to the farmers and also about the market prices. Farmers still use traditional methods and depend upon other farmers for information. Rural villages should be made as global villages by using the communication technologies. For collective bargaining and for

Livelihood assessment in Tamil Nadu

group mobilisation more farmers producer organisations may be formed in the villages. Farmers Producers Organization provides end-to-end support and services to the small farmers, which includes technical services, marketing, processing, and other supports. Farmer-based organisations (FBOs) which are a social capital component, could access financial support easily from local banks and microfinance companies as well from their own contributions. This will add up to improve their coping mechanisms during hard times and contribute to better their livelihood outcomes. Establishment of network among farmers can also be critical for extension educators who seek to disseminate new technologies. A network analysis can identify opinion leaders and progressive farmers within a network who can more effectively transmit the new knowledge to other network members. Rate of adoption of technologies by the farmers have stronger links to their social capital. Social networks may indirectly affect agricultural productivity by influencing farming practices and the household's propensity to adopt newer technologies via the supply of information through these networks.

Conclusion

The strategies discussed need to be adopted by the concerned policy making institutions and effective steps are to be taken for its implementation so as to improve the livelihood outcome of the tuber crops farmers. If the capitals of the farmers are improved by way of different interventions through various institutions can bring about a better change in the environment in which they are living. It is also necessary to analyse the policies and institutional context within which these capitals operates. While some capitals may be vulnerable to certain shocks, the concerned authorities and the existing system should act promptly to reduce the damage or to compensate the people when they are affected. The involvement of agencies and other department to reduce the external threats of farmer's livelihoods is very much required for the betterment of the farmers.

Reference

Jaganathan D., Sheela Immanuel, Prakash P and Sivakumar P S. 2020. Sustainable livelihood assessment of taro and paddy growers in Nayagarh district of Odisha. Journal of Community Mobilization and Sustainable Development.

BIOSENSORS IN FOOD INDUSTRY

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The world wide agri-food market has produced increased biological, chemical and physical threats to food products. As a result farmers and processors are using technological tools to allow the quick, effective and efficient determination of hazards inherent to safety and quality of products. Monitoring of safety and nutritional quality of food are very essential. The conventional analytical techniques for quality and safety analyses are very tedious and require trained personal. Therefore there is a need to develop quick, sensitive and reliable techniques for quick monitoring of food quality and safety. In this connection biosensor is an appropriate alternative to the conventional techniques. Biosensors are an important option in the agricultural and food sectors to control production processes and ensure food quality and safety by reliable, fast and cost efficient procedures. They are promising alternative for conventional analytical tools since they offer advantages in size, cost, specificity, rapid response, precision and sensitivity.

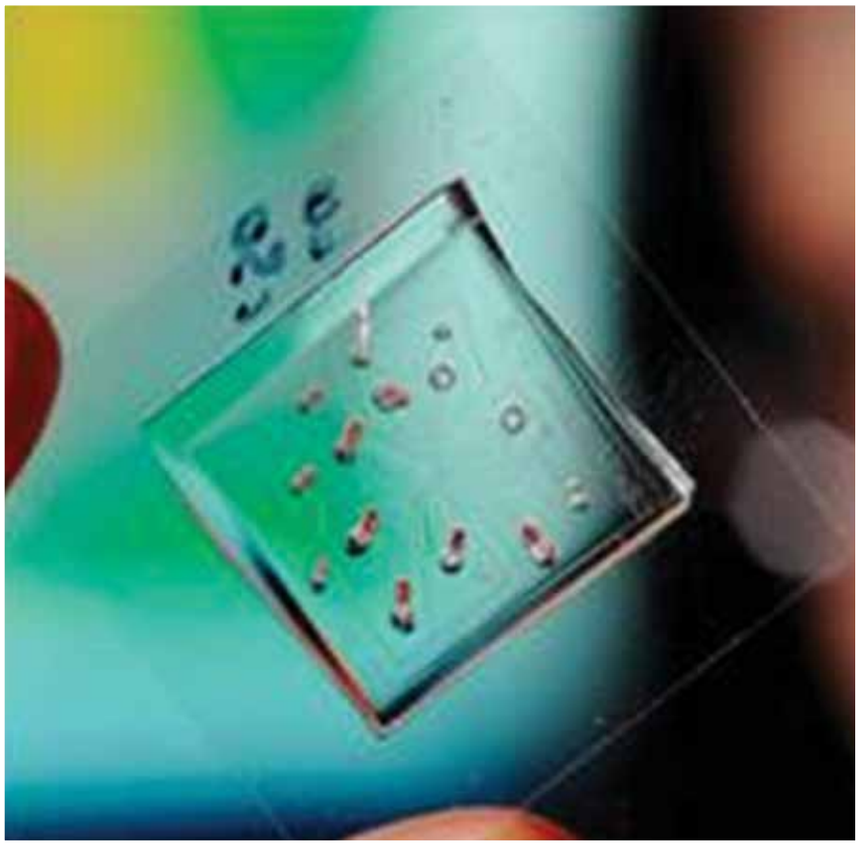


Fig. Biosensor

Fig. Detection element

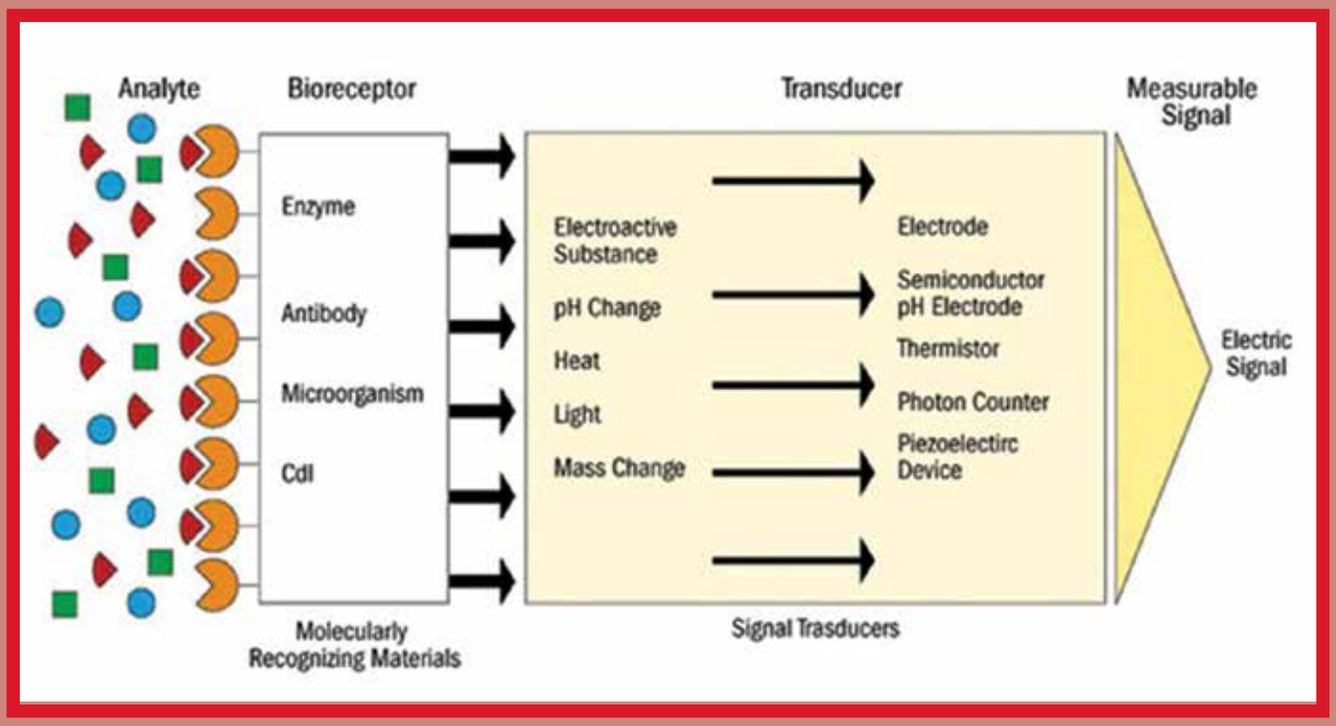


Fig. Components of a biosensor

The agriculture and food industry integrates the production, processing and commercialization of agricultural materials for specific markets and consumer demands. Each step in the agricultural and food production chain is susceptible to several threats since agricultural materials and food products are transported to different parts of the world, favouring the loss of quality and the transmission of diseases. Biosensor devices are emerging as one of the foremost relevant diagnostic techniques for food, clinical and environmental monitoring due to their rapidity, specificity, ease of mass fabrication, economics and field applicability. They obtain their specificity from biological binding reaction, which is derived from a range of interactions and nucleic acid hybridization in combination with a range of transducers.

Components of a Biosensor:

Biologically Active Material: A biological derived material is the one that interact with the analyte under study .e.g. Antibodies enzymes, microorganisms etc.

Detector Element: The detector element which is also called as transducer transform biological signal into another signal that can be measured more easily. i.e. amplified signal e.g. optical transducer, electrochemical transducer, calorimetric transducer etc.

Signal Processor: It is used to display the result in user friendly manner.

working principle of a biosensor is described below. The key component of a biosensor is the transducer which makes use of a physical change accompanying the reaction. This may be

- Heat output (or absorbed) by the reaction
- Changes in electrical or electronic output
- Redox reaction
- Light output or light absorbance difference between the reactants and products
- Based on mass of the reactants or products

The electrical signal from the transducer is often weak with heavy noise. To increase the signal to noise ratio a 'reference'

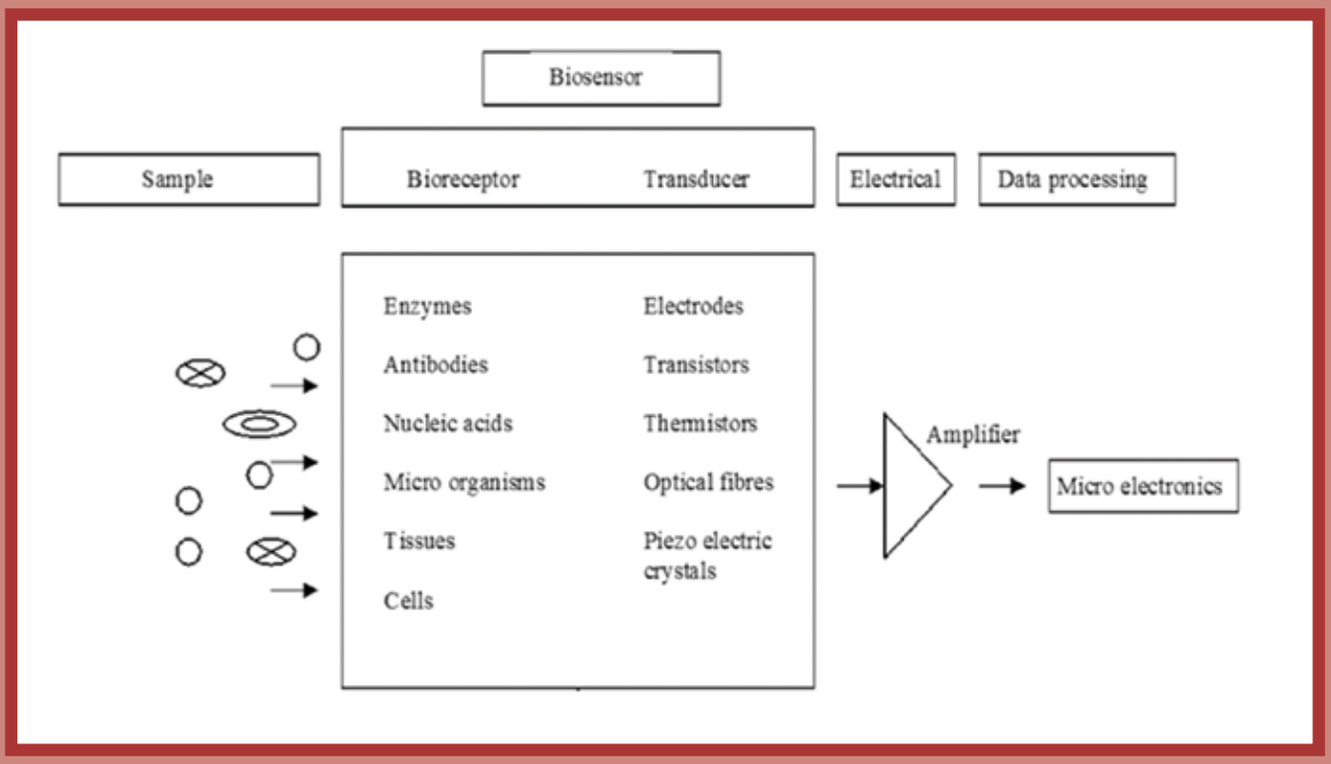


Fig. Working principle of biosensor

baseline signal derived from a similar transducer without any bio catalytic membrane from the sample signal should be used. The difference between the signals is very weak and amplified as a readable output. The above process removes the unwanted noise from the signal. The analogue signal produced by amplifier is usually converted in to a digital signal and passed to a microprocessor. The data is processed, converted in to concentration units and output to a display device or data store.

Classification of Biosensors:

Biosensor is broadly classified into two. First one is on the basis of biological active element and another one is based on the transducer element.

On the basis of biological element:

a) Enzyme Biosensor: Enzyme because of its high selectivity and activity towards substrate are the best candidate to be used as biologically active material. Most of the enzymes used in biosensor are oxidizes but there are certain limitations as their activity is susceptible to pH, temperature, ionic strength etc.

b) Microbial Biosensor: it uses microorganism as biological element .The metabolism of microorganism is used as basis of their activity. They are cheaper & versatile as compared to other sensor elements.

c) Antibody Based Biosensor: It uses antibodies as sensor. They are immobilized on the surfaces by

On the basis of transducing element:

a) Electrochemical transducers: The two common types of electrochemical transducers are Amperometric and Potentiometric transducer. In the Amperometric transducers the potential between the two electrodes is set and current produced by oxidation – reduction of electro active species is measured and correlated with the concentration of the analyte of the interest. The Potentiometric measures the potential of electrochemical cell with very low current value.

b) Optical Transducer: they

are used for determining the concentration of analyte on the basis of change in optical density at appropriate wavelength. I.e. Total Internal Reflection is measured with a Photo detector as a function of incident angle.

c) Calorimetric Transducers: it is used for calculating the heat of biochemical reactions by measuring the temperature difference between the reaction vessel and isothermal heat sink surrounding it.

Biosensor in food industries:

I) Enzyme biosensor for detecting food components:

Biosensor are used in industries as Wine, Beer, Soft drink etc. for detecting or measuring the carbohydrates from Alcohol, Amino acids, Amides

II) Biosensor for detecting bacteria in food:

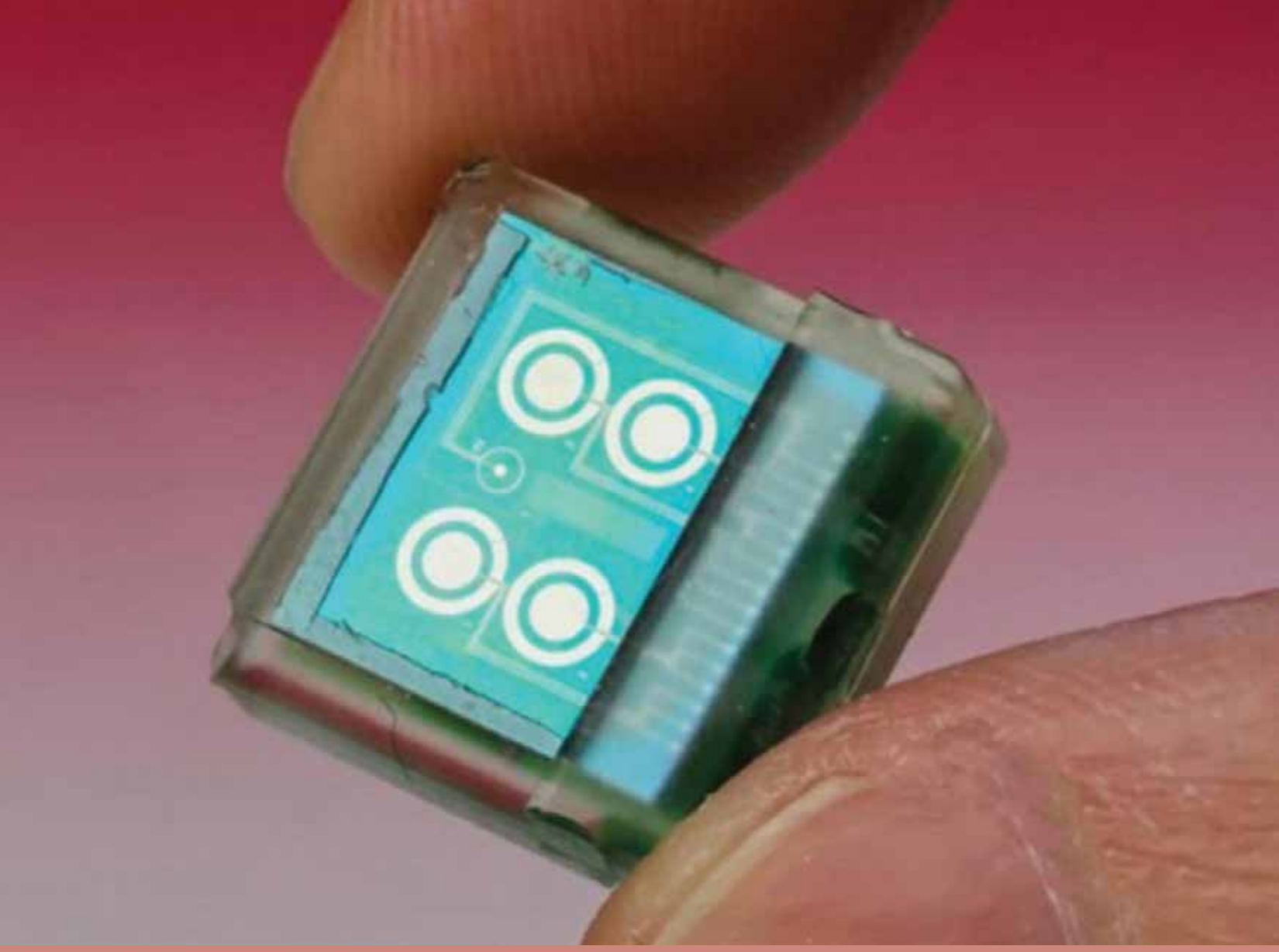
The detection of pathogenic bacteria can be done in two ways:

i) DIRECT DETECTION: These biosensors are those in which Biospecific reactions are directly measured in the time by measuring the physical changes induced by the complex formation.

- **Optical Biosensor:** These biosensors are used for direct detection of bacteria. These sensors are able to detect the small change in refractive indices, when cell behind to receptor which is immobilized on the transducer. The common optical biosensor which is used now a day is piezometric biosensor.
- **Bioluminescence Biosensor.** The use of photons as a byproduct of reaction for Bio analytical sensor led to the so called bioluminescence biosensor which may be use to detect the presence or physiological state of cell.

Electrical impedance

Fig. Colour indicating Biosensor



- **biosensor:** In this Biosensor microbial metabolism bring increase in both conductance and capacitance and thus cause a decrease in impedance. The biosensor is based on impedance measure of adherently growing cells on inter digitized electrode structure.
- **ii) INDIRECT DETECTION:** These biosensors are those in which a preliminary bio chemical reaction takes place and the product of the reaction are detected by a sensor.
- **Fluorescence labeled biosensor:** Microorganism have protein & polysaccharides in their outer coat which permit development of bioassays for bacterial detection.
- **Microbial metabolism based biosensors:** Micro organism is able to transducer their metabolic redox reaction in to quantify electric signals by using oxido reductase reaction and mediator
- **Flow immune sensors:** Many of the assays for microbes are based on Elisa using micro titration plates on completion of chromogenic reaction, the quantitative determination is done using Elisa reader (*E.coli* detection)

Prerequisites for a biosensor

While developing a biosensor system following requirements are very essential and considered for successful and commercial viable project.

a) Selectivity: The biosensor device should be highly selective for the target analyte and show minimum or no cross reactivity with moieties having similar chemical structure.

b)Sensitivity: The biosensor

device should be able to measure in the range of interest for a given target analyte with minimum additional steps such as pre-cleaning and pre-concentration of the samples.

c) Linearity of response: The linear response range of the system should cover the concentration range over which the target analyte is to be measured.

d)Reproducibility of the signal response: When samples having same concentrations are analyzed several times, they should give same response.

e)Quick response time and recovery time: The biosensor device response should be quick enough so that real time monitoring of the target analyte can be done efficiently. The recovery time should be small for reusability of the biosensor system.

f)Stability and operating life: As such most of the biological compounds are unstable in different biochemical and environmental conditions. The biological element used should be interfaced such that the activity is retained for a long time so as to marketable and practically useful in the field.

Application of biosensor in food industry

1.Biosensors in food security

Food Security refers to the availability and continuous, timely and permanent access to foods that meet quality and safety standards by the entire world population. Food agro-industrialization is a strategy that allows guaranteeing the continuous availability of foods. However, physical, biological, and chemical hazards from pre-harvest to storage and final product marketing, may affect food quality and safety. Biological hazards are primarily caused by microorganisms and their toxins, which may or may not affect the organoleptic properties of foods but nevertheless affect consumer health. Food poisoning and infections have a strong economic and social impact, causing loss of productivity due to morbidity and mortality.

Microbiological analyses during processing and on final products have been traditionally used to assure the control of these pathogens. These methods are based on the detection of potential pathogenic microorganisms through their isolation in differential and selective growth media, requiring long response times (ranging from 48 hours to 5 days) and also involving high identification costs. Another traditional method for the detection of pathogens in food and human and animal biological tissues is through enzyme-linked immunosorbent assays (ELISA). The ELISA test is based on qualitative or quantitative colour changes, using an enzyme as a reaction biomarker between an antigen and an antibody.

2. Biosensors used for the detection of bacteria

Salmonella are Gram-negative bacteria naturally found in the gastrointestinal tract of warm blooded animals and humans. When out of their natural habitat, these bacteria are able to survive in water and food products. The consumption of contaminated food products causes diseases such as enteric fever and salmonellosis. The majority of food processing plants are not equipped with water purification systems, and Salmonella becomes the principal biological contamination hazard. For the rapid detection of Salmonella, piezoelectric antigen-antibody biosensors are used. The advantage of using these biosensors with antibodies as the recognition element is their high specificity, sensitivity, chemical stability and rapid response; however, as mentioned earlier, the low specificity achieved by polyclonal antibodies may be a drawback in some sensors. These biosensors are used in water sanitation control, which is required in all food transformation processes. They are also used in milk production and in the control of milk products, including milking equipment, pollution system, pumps, farms or livestock stables, processing industry and finished products.

Biosensors offer

advantages over traditional methods that need longer test time and specific growth media before the pathogen is detected. The use of optical biosensors allows the reaction between receptor and analyte, providing confidence, specificity and less time for detection. The excitation of atoms related to the receptor-analyte reaction, results in mass, energy and physical changes that are captured by the biosensor. In this way, real time data is used to identify bacteria, viruses or toxins. The infection caused by *E. coli* results from ingesting food, mainly fresh fruits and vegetables, and/or contaminated water. Infections may also be caused by eating poorly cooked animal foods or foods that were washed with contaminated water. *E. coli* detection in shorter time has been done using amperometric biosensors, through the detection of hydroxyl radicals produced by *E. coli* oxygen reduction during aerobic metabolism.

3. Biosensors used for the detection of heavy metals

Heavy metals are toxic substances that accumulate in the organism and cause metabolic alterations since there is no way of metabolizing or excreting them. We may accumulate heavy metals when eating foods of animal origin, since animals have greater contact with poorly treated water, can graze close to industries, and even eat foods treated with water contaminated with heavy metals. Bi-enzymatic biosensors are used to detect enzymes inhibition in water. Enzymes like alkaline phosphatase and acetyl cholinesterase are inhibited by the presence of heavy metals, carbamates and organophosphates. Conductometric biosensors use immobilized Chlorella vulgaris microalgae as bio receptor

4. Biosensors as indicators of product acceptability

Food quality involves nutritional and organoleptic characteristics important for consumers such as freshness, appearance, taste and texture. The food sensory basis is essential for the industry. A method to determine food freshness is by assessing food composition of products such as meats, fish, fruits and vegetables. During storage, compounds that provide aroma and abnormal flavors or may be harmful to consumer may be synthesized, indicating in most cases microbial growth and insufficient food safety.

Conclusion

Living organisms, biological components like antibodies and enzymes work as natural sensing and controlling devices. The selectivity, specificity, and rapid response depend on the biosensor's reception and transduction systems, since they are based on recording reactions that generate physical, chemical and/or immunological changes. This form of reading that allows for a rapid response is ideal in the agri-food process control. A biosensor is an inexpensive, portable and suitable analytical tool. This paper summarises not only the current application but also the future use of biosensors in food industry, the sensors would need to meet monitoring demands, providing multi analyte detection and being wireless signal transmitters for remote sensing.

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ORGANIC WEED MANAGEMENT BY CULTURAL METHODS

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Today, organic farming is growing and expanding in Kerala. This is due to the increasing use of natural resources, lower cultivation costs, higher soil fertility, better input utilization efficiency, increased self-reliance, etc. Thus, organic farming has better economic and environmental benefits.

Its biggest challenge is its low yield compared to conventional farming and it is due to the high weed competition in the initial days of main crop. Weeds are unwanted or undesirable plants that compete with crops for water, soil nutrients, light and space and thus reduce crop yields. Cultural weed control is a multi-year, whole-farm, multi-faceted approach for reducing the weed pressure. Writing in 1939, German agricultural researcher Bernard Rademacher stated, "Cultural weed control should form the basis for all weed control," and that "the other various means should be regarded as auxiliary only. The necessary condition for any successful weed control is the promotion of growth of the crop species. Vigorous plant stands are the best means for eradicating weeds." The same wisdom must be applied to organic agriculture today, actively incorporating the philosophy that good agronomic practices that result in vigorous, competitive crop plants are the real key to successful weed control. Many agronomic procedures that encourage healthy soil conditions with a diverse microbial population can also reduce weed pressure.

Crop Rotation

Inter cropping

Optimizing the biological terrain of the soil for the crop will create an unfavorable environment for many weeds, effectively reducing weed numbers and vigor. This concept forms the core of effective weed control in an organic production system. It is important to know your enemy. All weed species have their weaknesses and their strengths, usually occurring at distinct stages of their life cycles or resulting from specific growth patterns. Different weeds present problems at different times of year, or with different crops. Some weed-control strategies, such as disking a field infested with quack grass, may even increase the prevalence of certain species of weeds under specific conditions. Grassy weeds often require different control

Cover Crops

measures than do broad-leafed weeds. Correctly identifying the species of weeds that are causing major problems in your fields is critical to choosing and timing effective control measures. It is valuable to have a good weed-identification book and use it regularly during the season until you are confident recognizing your most common and troublesome weeds.

Since chemical herbicides cannot be used for the control of weeds, the available other options are different cultural and mechanical methods. Since mechanical methods are very laborious and time consuming various cultural practices can be adopted easily. The different cultural practices are:

1. Crop Rotation

Crop rotation involves alternating different crops in a systematic sequence on the same land. Weeds tend to thrive with crops of similar growth requirements as their own and cultural practices designed to contribute to the crop may also benefit the growth and development of weeds. Monoculture, that is growing the same crop in the same field year after year, results in a build-up of weed species that are adapted to the growing conditions of the crop. When diverse crops are used in a rotation, weed germination and growth cycles are disrupted by variations in cultural practices associated with each crop (tillage, planting dates, crop competition, etc.).

2. Cover Crops

Rapid development and dense ground covering by the crop suppress weeds. Highly competitive crops may be grown as short duration 'smother' crops within the rotation. Cover crops can suppress weeds, reduce weed populations in the subsequent crop, and reduce weed seed contributions to the soil seedbank.

3. Inter cropping

Intercropping involves growing a smother crop between rows of the main crop. Intercrops are able to suppress weeds. However, the use of intercropping as a strategy for seed control should be approached carefully. The intercrops can greatly reduce the yields of the main crop if competition for water or nutrients occurs.

4. Mulching

Applying mulch after planting can offer some benefits in many cropping systems. Mulches

Mulching

reduce weed competition by limiting light penetration and altering soil moisture and temperature cycles.

Living mulch: Living mulch is usually a plant species that grows densely and low to the ground such as clover. Living mulches can be planted before or after a crop is established. It is important to kill, or manage living mulch so that it does not compete with the main crop in later stages.

Organic Mulches: Organic mulches include many materials that can be produced on-farm such as hay, straw, grass mulch, crop residues, and livestock or poultry bedding. Other materials, such as leaves, composted municipal wastes, bark, and wood chips, may be available from off-farm sources.

6. Stale Seedbed Preparation: This weed management strategy consists of preparing a fine seedbed, allowing weeds to germinate by providing irrigation and directly removing weed seedlings via light cultivation or flame weeding. Seeds or transplants can then be planted into the moist weed-free soil. This technique helps to provide an opportunity for crop emergence and growth before the next flush of weeds. If time allows, this can be done twice before planting.

7. Soil Solarization: Solarization consists of heating the soil to kill pest organisms, including fungi, bacteria, and weed seeds. Soil is covered in summer with clear or black polyethylene plastic and moistened under the plastic, which is left in place for six to seven weeks or longer. Weed seeds and young seedlings are killed by the heat and moisture and through direct contact with the plastic, which causes scorching.

Conclusion

Cultural methods of weed control really helps a farmer who is experienced in cultivation to control weeds without hurting the main crop. One last word about cultivation and organic weed control is trying too hard to get every last weed in a field can waste time, labor, and may actually do damage to the crop. It is important to keep the whole crop in perspective, and not spend too much time making the first few fields immaculate.

Internet of things **Solutions for smart farming**

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INTRODUCTION

Internet of things (IoT) is the network of physical objects or "things'' embedded with electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data. IoT is an environment where objects, animals or people are equipped with unique identifiers capable of data transmission over internet network without the need for human- human or human -computer interaction (Gluhak et al., 2011). With sensors and IoT enabled devices, lot of data can be generated in real-time. Rapid analysis of this real time data helps us to make decisions faster and to guide precise adjustments to operational processes (Christine and Chen, 2020).

IOT ARCHITECTURE

The IoT architecture is made up of three layers, namely perception layer, network layer and application layer. The perception layer is used to collect data. It is then transmitted to the network layer which acts as the Central Nervous System for further processing. In this layer, data aggregation, data filtering, and transmission takes place. The last layer is the application layer, where the data integrity, data confidentiality and data authenticity are guaranteed (Swamy et al., 2017).

DIMENSIONS FOR IOT

The idea of the IoT was introduced in a technical report of the International Telecommunication Union. This report suggested four dimensions for IoT namely item identification (tagging things), sensor and wireless sensor networks (feeling things), embedded system (thinking things) and nano-technology (shrinking things) (Patil et al.,2012).

Tagging things: Radio Frequency Identification Tags (RFID) shows several differences and advantages over previous technologies like barcode. They do not require direct line of sight to the reader and thus can be embedded in an item, placed inside the packing or injected inside the body of animals.

Feeling things or sensing things: Sensor devices are used to measure the information and transform into an output. Different sensors are used in agriculture. Passive Infrared (PIR) sensors are used to check range of movement of a person or any object. Soil moisture sensor is used to measure the moisture content and water quantity in the soil. Temperature sensor is used to sense any changes in temperature of the soil. Humidity sensor is utilized to sense and measures the humidity level in air. It also measures the actual air temperature and moisture ratio in air. Water level sensor has sensing probe, which senses surface level of fluid based on its voltage. Chemical sensors sense any chemical reaction, chemical substance or a set of chemicals. A pH sensor measures pH value based on hydrogen ion concentration by using pH electrode as sensor.

Embedded things: Embedded things include microcontrollers, which are compact integrated circuit designed to govern a specific operation in an embedded system. Aurdino and Raspberry Pi is the mostly used microcontroller in agriculture (Parvati and Megha, 2018).

APPLICATIONS OF IOT IN AGRICULTURE:

Smart irrigation system: Global System of Mobile

communication (GSM), which is based on automatic irrigation control system, is developed for the efficient use of resources and crop planning. The system supports water management decision and used for monitoring the whole system with GSM (RS-232) module.

Agricultural drones: These are used for crop surveillance, which can drastically minimize the usage of human power. Drones are commonly used for surveying and assessing the soil chemical composition, field status, crop spraying and irrigation, thereby reducing the cost of production.

Greenhouse automation: An automated greenhouse monitoring and controlling system was incorporated with various sensors and microcontroller together to collect process and store the data of possible environmental parameters in the greenhouse. Processed output was sent to the android apps which have been developed for monitoring and controlling of greenhouse by the user.

Predictive analytics: The collected data may include commodity, prices, satellite images, coordinates of farms, etc. that is generated from various fields with the application of various IoT devices. The analysis of these data provides valuable insights in precision agriculture that can help the farmers to increase the productivity and revenue by reducing the cost of production.

Smart hydroponics system: It consists of variety of sensors that acquires varied data like water, pH level, fertilizers level, room temperature, humidity and light for the efficient use of resources and decision making.

Agricultural machinery: IoT based agricultural machinery can help in improving crop productivity and reducing grain losses by proper mapping using global positioning and global navigation satellite systems. This machinery can be operated in autopilot mode.

Precision Agriculture: Precision agriculture can be defined as the collection of real-time data from farm variables and use of predictive analytics for smart decisions in order to maximize the yield, minimize the environmental impacts and reduce the cost of production by restricted use of chemicals and labor.

Monitoring: Soil monitoring assists farmers in tracking and improving the quality of soil to avoid degradation. Climatic condition monitoring helps to observe the crop conditions and the environment around them. An alert will be sent if they found any bad weather conditions. IoT ecosystem is designed with sensors that can identify the real time weather conditions.

Crop management: Devices are placed in farm to gather information on crop cultivation, precipitation, water efficiency and overall health of the crop. Crop growth and other irregularities are monitored to prevent pest infestation or diseases that could harm yield.

DISADVANTAGES OF IOT

Excess power consumption and energy usage, unemployment, difficulty in working and maintenance and lack of flexibility are some of the bottlenecks. Privacy and security are also greatly compromised (Andrew et al., 2015).

CONCLUSION

Indian agriculture is far away from modernization. The use of IoT in agriculture will help to overcome the problem of global warming and environmental change. It could effectively solve the issues concerning farmers, agriculture and rural sector. A perfect use of modern technology along with IoT can stimulate rapid modernization in agricultural system.

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Gardening has long been considered a therapeutic activity, and with the rise of horticultural therapy, its benefits are being recognized and utilized in a more structured way. Horticultural therapy is a type of therapy that involves using plants and gardening activities to improve physical, mental and emotional well-being. This innovative approach to therapy recognizes the power of nature and the positive impact that interacting with plants can have on an individual's health and happiness. From reducing stress and anxiety to improving cognitive function and physical health, the benefits of horticultural therapy are numerous. In this article, we'll explore the concept of horticultural therapy, its benefits, and how it can be used to improve physical, mental, and emotional well-being.

Horticultural therapy is commonly used to help people with various mental and physical health issues, including depression, anxiety, stress, and conditions such as Alzheimer's disease and other forms of dementia. It is also used to

"Gardening for well-being: the power of horticultural therapy in improving physical, mental and emotional health"

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help individuals with disabilities and to improve their social and communication skills.

Horticultural therapy is often used in a variety of settings, including hospitals, nursing homes, rehabilitation centers, schools and community gardens. The therapy is usually conducted under the supervision of a trained horticultural therapist, who provides guidance and support to the individual as they engage in gardening activities.

Some of the benefits of horticultural therapy include:

1.Improved physical health: Gardening activities, such as digging, planting and weeding, can help improve physical health by providing low-impact exercise.

2.Mental health benefits: Engaging in gardening activities can reduce stress, anxiety, and depression. This is because it provides a sense of accomplishment, helps reduce negative thoughts, and promotes a sense of relaxation and tranquility.

3. Social benefits: Horticultural therapy can help individuals improve their social and communication skills. This is because gardening activities often involve working with others and can provide opportunities for social interaction.

4.Improved cognitive function: Horticultural therapy can help improve cognitive function by providing stimulation for the brain. Gardening activities, such as planning and organizing, can help improve problem-solving skills and memory.

Horticultural therapy is a unique form of therapy that has a positive impact on the physical, mental, and emotional well-being of individuals. By providing opportunities for physical activity, social interaction, and mental stimulation, horticultural therapy can help individuals improve

their overall health and quality of life.

HORTICULTURAL THERAPY TECHNIQUES

Horticultural therapy is a growing field and there are various techniques and approaches used to promote well-being through gardening activities. Here are some common horticultural therapy techniques:

1.Planting and Cultivating: This involves the process of planting and growing seeds, seedlings and mature plants. This activity can help to improve fine motor skills and hand-eye coordination.

2.Garden Design and Landscaping: This involves creating and designing a garden space that meets the needs of the individual. It can help to improve problem-solving skills and creativity.

3.Nature Walks and Observations: This involves taking a walk in nature, observing plants and wildlife, and learning about the natural environment. This activity can help to reduce stress, improve mood and increase knowledge and appreciation for nature.

4.Sensory Gardening: This involves using the sense of touch, smell, sight, and sound to interact with plants and nature. This activity can help to improve sensory awareness and provide stimulation for individuals with cognitive and sensory challenges.

5.Therapeutic Horticulture: This involves using plants and gardening activities to treat specific health conditions, such as reducing stress and anxiety. This activity can also help to improve physical, emotional, and mental well-being.

6.Group Gardening: This involves working in a group to cultivate a garden and can help to improve social skills, communication and teamwork.

These are just a few examples of the techniques used in horticultural therapy. The activities used in horticultural therapy can be tailored to meet the individual's needs, abilities, and interests. By combining gardening activities with therapeutic goals, horticultural therapy can help individuals improve their overall well-being.

HOW MUCH PERCENTAGE HORTICULTURAL THERAPY WORKS

The effectiveness of horticultural therapy is well

documented, and it has been found to be effective in improving a wide range of physical, mental, and emotional health conditions. However, it is important to note that the effectiveness of horticultural therapy can vary greatly depending on the individual and the specific health condition being treated.

Studies have shown that horticultural therapy can be effective in reducing symptoms of depression, anxiety and stress. For example, a study published in the Journal of Therapeutic Horticulture found that horticultural therapy was effective in reducing depression symptoms in older adults with depression and anxiety.

In individuals with dementia and Alzheimer's disease, horticultural therapy has been found to improve cognitive function, reduce agitation and behavioral symptoms and improve quality of life.

In individuals with physical disabilities, horticultural therapy has been found to improve physical function and mobility, as well as improve overall well-being.

Overall, the percentage of success of horticultural therapy depends on many factors, including the individual's specific health condition, the type of horticultural therapy used, and the frequency and duration of therapy. However, many studies have shown that horticultural therapy is an effective tool for improving physical, mental and emotional well-being.

Horticultural therapy is a type of therapy that involves using plants and gardening activities to improve physical, mental, and emotional well-being. This form of therapy is based on the idea that interaction with nature and the act of gardening can have a positive impact on an individual's health.

Horticultural therapy is commonly used to help people with various mental and physical health issues, including depression, anxiety, stress and conditions such as Alzheimer's disease and other forms of dementia. It is also used to help individuals with disabilities and to improve their social and communication skills.

Horticultural therapy can be performed in various settings, including hospitals, nursing homes, rehabilitation centers, schools and community gardens. The therapy is usually conducted under the supervision of a trained horticultural therapist, who provides guidance and support to the individual as they engage in gardening activities.

The benefits of horticultural therapy are numerous. For example, gardening activities, such as digging, planting and weeding, can provide low-impact exercise and improve physical health. Engaging in gardening activities can also reduce stress, anxiety and depression by providing a sense of accomplishment, reducing negative thoughts, and promoting a sense of relaxation and tranquility. Horticultural therapy can also help individuals improve their social and communication skills by providing opportunities for social interaction. Additionally, gardening activities can stimulate the brain, improving cognitive function and problem-solving skills, and memory.

Horticultural therapy is a unique form of therapy that has a positive impact on the physical, mental, and emotional well-being of individuals. By providing opportunities for physical activity, social interaction, and mental stimulation, horticultural therapy can help individuals improve their overall health and quality of life. In conclusion, horticultural therapy is an effective tool for promoting well-being, and its benefits are well documented. By using plants and gardening activities, individuals can improve their physical, mental, and emotional health, and lead a happier and more fulfilling life.

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Nutra Rich

Indian Carrot Varieties

Production of nutra-rich carrots will be a rewarding activity for vegetable growers as we enter the 21st century. The world population is expanding very rapidly and expected to grow around 8 billion in 2020s with very high numbers of undernourished people. About 50% of the world population suffers from malnutrition deficiencies particularly in developing countries. In industrialized countries where sufficient food is available to most of the population, there is an increasing realization that nutritious vegetables can play an important role in assuring a healthful life style and that eating is not solely for sustenance and body growth. The chief immediate

Rich in Antthocyanin

Pusa Asita

Pusa Meghali

Rich in B Carrotin

and long term objective of nutra-rich carrot production is to enhance productivity and quality attributes of carrots including nutraceuticals, colours and bioactive compounds etc. to meet the ever increasing food requirement of people. However, people are health conscious and use to take coloured vegetables rich in vitamins, minerals, antioxidants, nutraceuticals and bioactive compounds. Nutra-rich carrots, of late, gained importance as health conscious society is looking for such substance which encompasses nutritional and pharmaceutical value. Carrots have inherent advantage of high variability in various nutraceutical compounds, thus there is scope of further enhancing the production and productivity of different nutra-rich carrots by growing specific nutrient rich Indian varieties. Such biofortified

Rich in lutain

Pusa Kulfi

carrot varieties will, in addition to fresh market, be suitable for industry for extraction of nutraceuticals paving the way, thereby, for contract farming.

Carrot *(Daucus carota L.)* is the most important biennial winter root vegetable crop. It has rich sources of β-carotene, lycopene, lutein and anthocyanin in orange, red, yellow and black colour of carrot respectively. In recent years, the consumption of carrot and its products have increased steadily due to their recognition as an important source of natural antioxidants besides, anticancer activity of β-carotene being a precursor of vitamin A. The important varieties of carrot grown in different parts of India are Pusa Kulfi, Pusa Kesar, Pusa Asita, Pusa Kulfi, Pusa Nayanjyothi, Pusa Vasuda, Pusa Payasa, Pusa Yamdagni, Pusa Meghali, Pusa Nayanjyothi, Pusa Rudira,

Round Year Production of nutra-rich carrots

Variety/Hybrid	Sowing time	Availability	Yield (q/ha)
Pusa Vrishti	July to August	October to November	180
Pusa Rudhira	September to October	November to January	300
Pusa Asita			270
Pusa Vasuda			400
Pusa Yamdagini	September to March	November to April	280
Pusa Nayanjyothi			340
Pusa Vrishti	March to April	May to June	120

Varieties suitable for Rabi season

Variety/Hybrid	Days to 1st Harvest	Yield (t/ha	Suitable areas
Pusa Rudhira	75-90	30	Delhi & NCR
Pusa Asita	90-110	27	Delhi & NCR
Pusa Vasuda	80-90	40	Delhi & NCR
Pusa Nayanjyothi	80-85	35-45	Low temperature

Fig 1. Nutra rich carrot varieties

Zeno, Early Nantes, Nantes, Nantes Half Long, Imperator and Chantenay (Selvakumar, 2016). Due to its versatile uses, there are number of vegetable preparations and sweet dishes which are cooked alone or with other vegetables in the preparation of soups, stews and pies, fresh grated roots are used in salad, tender roots are pickled. Processed products of carrot supplement to human diet such as murrabba, chips, canned slices, juice, concentrate, pickle, preserve, cake, halwa, strips, cubes, squares, flakes intermediate moisture foods, dehydrated, osmo-dehydrated, frozen canned product and various types of ready to serve beverages such as carrot juice, flavoured and blended beverage (Kalia, 2010; Selvakumar, 2011). Though there is sufficient production of orange and red carrots in India, yet its production and availability to consumers particularly in Southern India are scanty and meager. Due to seasonal and types of carrots are varying region to region, and place to place. The scientific information of nutra-rich carrot production and different coloured varieties to the farmers are less and unknown. Therefore, its need to make aware and transfer information about technical production of nutra-rich carrot cultivation, its round year production and varieties available to farmers are timely needed. These technical details are discussed in the following headings and subheading.

Nutra-rich varieties

Pusa Rudhira (IPC122)-Red coloured

This variety is a new tropical red variety released in 2010 (Fig 1). It is suitable for main season sowing beginning with September in north Indian plains. It is characterized by dark green foliage and long red coloured self core. It takes about 75-90 days to reach marketable maturity. Average root yield of 30 tonnes/ha. This variety rich source of total carotenoid content (7.60mg/100g), lycopene 6.70 mg/100g, β-carotene 4.92mg/100g of fresh root weight.

Pusa Meghali-Orange coloured

This is a selection from a cross of Local red × Nantes Half Long developed at IARI, New Delhi (Fig 1). It has orange coloured tapered roots with self coloured core. The roots are rich in beta carotene content (11571 IU/100g). Suitable for early sowings (August-September). It gives a yield of 25-30 tonnes/ha. This variety is capable of seed setting in North Indian Plains.

Pusa Asita (IPC-126)-Purple coloured

This is a selection from IPC-126 developed at IARI, New Delhi (Fig 1). It has smooth, round shouldered black coloured self-core and obtriangular. Suitable

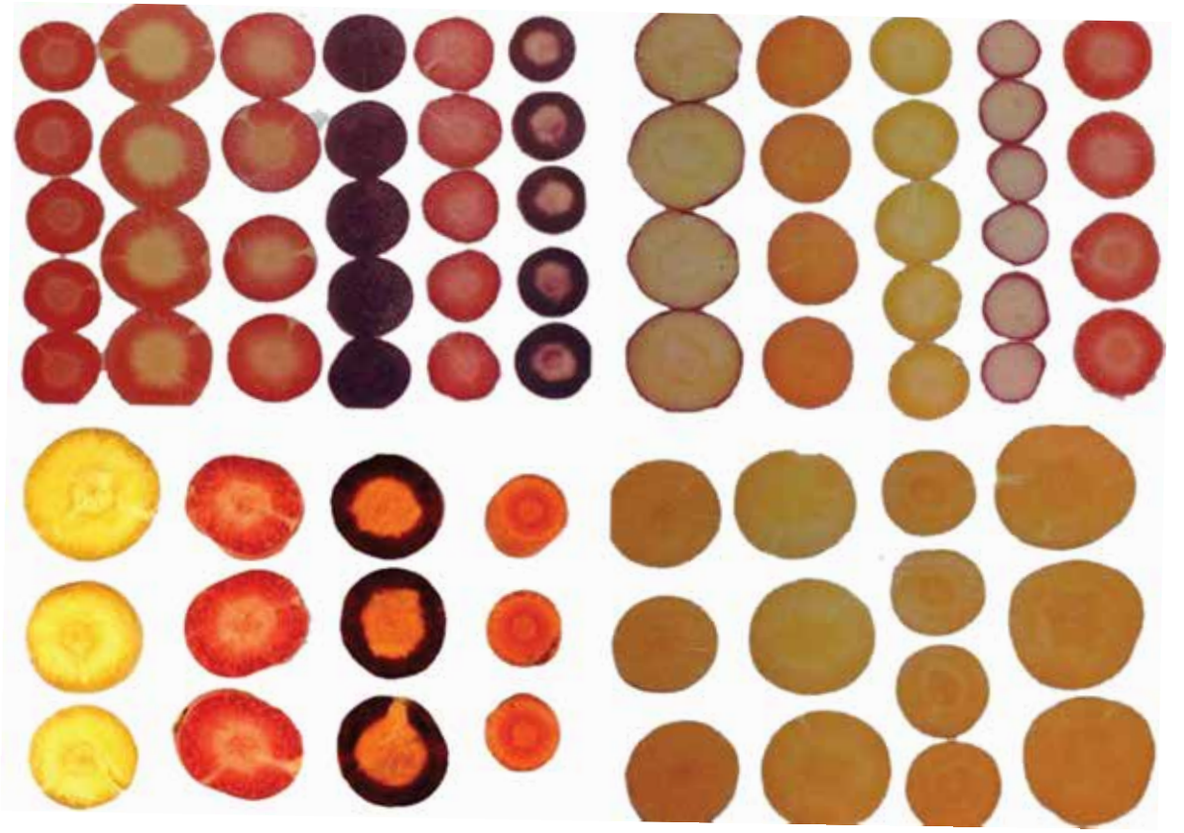

Fig. 2. Different colour expression in carrot cross

for early sowing (from early-November to early January), it matures in 90-110 days and yields 27tonnes/ha. It contains 520 mg anthocyanins /100g fresh weight.

Pusa Kulfi-White Pale coloured

It is white pale mustard colour carrot variety suitable for normal season sowing (Fig 1). It matures 90-100 days and yields 24-25t/ha. It has cream mustard colour, self coloured core, and obtriangular with slight greenish purplish tinged shoulder. It is sweet, juicy and suitable for salad, juice extraction and cooking.

It contains lutein 2.81μg/100g fresh weight. Vegetable growers have an unprecedented opportunity to address human nutritional needs by growing nutra-rich carrot cultivars in different seasons. Because complex factors are often responsible for carrot production, care must be taken initially to determine the feasibility of successful cultivation as an intervention strategy that will result nutra-rich carrots in the actual alleviation of nutritional problems in well-defined, targeted human populations. Cultivating nutraceutical rich carrot is best way for supplement to consumers as well as nutraceutical industry along with alleviation of vitamin deficiency. Through breeding scientist have developed vegetable new varieties viz., anthocyanin rich variety-Pusa Asita, Lycopene rich variety-Pusa Rudhira, β-carotene rich variety-Pusa Nayanjyothi which will be suitable for nutra-rich vegetable industry as well as fresh market.

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GARDEN RUE

A WONDER PLANT

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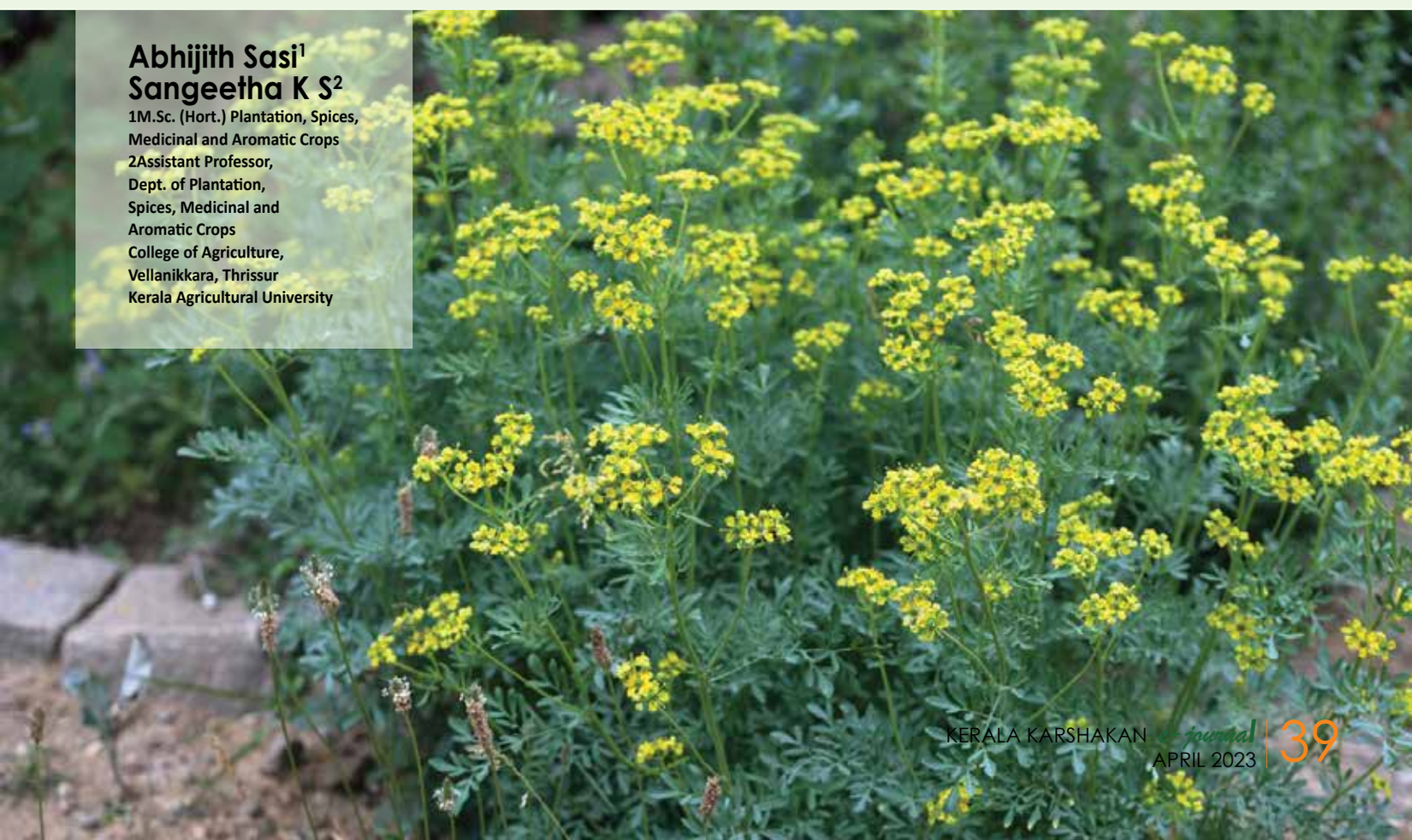

INTRODUCTION

Garden Rue,scientifically known as *RutagraveolensL.* is a medicinal plant belonging to the Rutaceae family. It is a well-known plant with both traditional and modern pharmacological application. It serves as a stimulant, emmenagogue, diuretic, abortifacient, and resolvent in traditional medicine.The plant *Rutagraveolens L.* has attracted more attention in contemporary medicinal chemistry because of its usefulness in the treatment of a wide range of human diseases as well as the presence of a huge number of compounds belonging to different classes of natural products, including neuroactive compounds potentially able to promote neuroprotection.It is called as "Arutha" in Malayalam and is widely used in folk medicine by locals in the higher altitudes of Kerala.

ORIGIN AND DISTRIBUTION

Although widely dispersed over all temperate and tropical zones, it is indigenous to Europe, particularly the Mediterranean region. In South America, it is a widespread and beautiful garden shrub that is grown not only for decorative and therapeutic purposes but also due to the notion that it offers protection from evil.

MORPHOLOGY

Rutagraveolens L. is a subshrub or perennial herb, strongly aromatic. The stem is up to one metre tall, smooth, and pale glaucous green in colour. The leaves are alternating, 2-3 pinnate, compound, glaucous, gland-dotted and silvery to blue green. Leaflets are oblong or linear-oval in shape. Corymbose, erratically dichotomous terminal inflorescences are present. Flowers are regular bisexual, terminal ones are pentamerous and others are tetramerous. The petals are distinct, widely spreading, greenish yellow, wide and hooded at the top, abruptly joined to the slender claw below, and occasionally serrated. Fruits are 4-5 blunted lobed, dry, rigid, and roundish in shape.

GARDEN RUE AND KERALA

The Western Ghat Region of India is one of the most popular and promising areas due to

its unique agroclimatic condition and vast supply of medicinal plants. In Kerala it is mainly seen in the districts of Idukki and Wayanad, in these districts apart from the occurrence in the wild, the plant is also grown by the locals in their garden and the leaves and aerial parts are used to treat children's stomachaches, indigestion, headaches and skin diseases. They also employ its pungent odour to ward off insects like mosquitoes.

BIOCHEMICALS

Ruta graveolens has the flavonoid glycoside 'Rutin' which is the active ingredient in it and has got antioxidant, anti-inflammatory, and antirheumatic activities. According to a high-resolution gas chromatographic examination of the secondary metabolites extracted from *Ruta graveolens L.* extracts from the plant's leaves, flowers, stems, and roots using subcritical fluid, yielded 78, 45, 25, and 24 distinct chemicals, respectively. A gas chromatography-mass spectrometry analysis and in vitro antioxidant activities of *Ruta graveolens L.* from the western ghats region showed that the three main substances found were, 2-nonanol (34.25%), 2-nonanone (32.15%) and nonyl ester (15.43%). 2-dodecanone (2.77%), Tridecanone (2.54%), and tumeronol (2.16%) were the other crucial ingredients.

PHARMACOLOGICAL APPLICATION

1. Antimicrobial

Reddy and Al- Rajab (2016) studied the chemical composition, antibacterial, and antifungal activity of *Ruta graveolens L.* volatile oils and found out that it showed inhibition for both gram +ve and gram -ve bacteria including some common human pathogenic bacteria. The volatile oil also showed anti-fungal activity of which highest inhibition was shown against *Candida albicans*.

2. Anti-inflammatory

Methanolic extracts of *Ruta graveolens L.* were studied for its anti-inflammatory effect and itwas found out that 50 mg/kg of body weight showed 90.9% inhibition on rat paw edema.

3. Anti-cancerous activity

Rethyet al. (2007) studied the anti-cancerous effect of furanoacrodines isolated from *Ruta graveolens L.* and they found out that the acridone alkaloid, such as furanoacrodines, may be employed as a starting point for the creation of novel anti-cancerous drugs.

In another study conducted by Valle et al. (2022) on the in vitro antitumor activity in breast cancer cells of *Ruta graveolens* in homeopathic dilution (Ruta D 35), and the findings show that *Ruta graveolens* in ultradiluted form possesses antitumor properties as it revealed that the SKBR3 and PMC 42 breast cancer cells had suffered in vitro cytotoxic damage.

Gentile et al.(2015) reported that the extracts of garden rue selectively kill proliferating (i.e., tumour cells) Glioblastoma cells and not the non-proliferating neurons. As a result, it may be a useful tool for

GC-MS analysis of volatile composition of essential oil of Rutagraveolens L.

Sl. No.	Compound	Composition (%)
1	2-Nonanone	32.15
2	Methyl nonyl ester	15.43
3	2-Nonanol	34.25
4	2-Undecanone	0.29
5	2-Dodecanone	2.77
6	3-Tert-butylcatechol	3.42
7	2-Tridecanone	2.54
8	4-Hydroxy-3-pentyl-cyclohexanone	0.24
9	Hedycaryol	1.41
10	2-Pentyl-cyclohexane-1,4-diol	0.05
11	Gamma eudesmol	0.09
12	4-Amorphen-11-ol	0.18
13	2-Phenyl1-1,4-(ethylene-1',2'-diyl)	0.54
14	Cyclohexane	2.16
15	Tumeronol B	0.04
16	9,12,15-octadecatrienal	0.14
17	Phenanthrene	0.31
18	Phytol	0.81
19	(2E)-7-(3',4'-methylenedioxyphenyl) 2-heptenoic acid	1.95
20	Trans-4-anisylcinnamic acid1-Hexadecanol	0.05

both identifying targets for therapeutic intervention and isolating new medicines.

Besides these pharmacological uses, *Ruta graveolens L.* showed some other application such as anti-arrhythmic, antipyretic, antioxidant, analgesic, antihyperglycemic, free radical scavenging, hypotensive, antiviral, and antiplasmodial, anti-androgenic, anti-conceptive and anti-fertility properties.

GARDEN RUE IN AYURVEDA

It isn't mentioned in traditional Ayurvedic texts but the pharmacopoeia and late Ayurveda nighantus both describe it, though. In 19th century it was initially mentioned as a "Sarpdanshtra" and its therapeutic powers were mentioned in *Bhruhat Shaligram Nighantu Bhushanam* (Arthat Brihatnighantargat NighantuRatnakar). The properties such as Rasa Tikta, VeeryaUshna, and reducing Kaphadosha were described in this text. Its action against cough and cold were mentioned in VanaushadhiChandrodaya and VanaushadhiGunadarsh and the former also has information about treatment for scorpion bite. Nighantu Adarsh has information regarding its use against Dysmenorrhea. DravyagunaVigdynan described it as "Ushnaveerya".

GARDEN RUE IN UNANI

In Unani it is used against obesity (Saman-e-Mufrat), dyslipidemia (Fart-e-Tadassum-Fid-Dum), atherosclerosis (Salabat-E-Nabz), anti-helminthic (Deedan-e-medadwaamma),anti-inflammatory & analgesic (Muhallil and DafeAlam) etc.

CONCLUSION

Ruta graveolensL., commonly known as Garden rue, is a medicinal plant widely seen around the globe and is grown in the homestead gardens of Idukki and Wayanad district of Kerala. It has numerous pharmacological applications in the traditional folklore system of medicine, Ayurveda, Unani, and modern allopathic medicine.

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Introduction

Turmeric is a rhizomatous, herbaceous perennial plant native to tropical South Asia and belongs to the Zingiberaceae family. India produces the majority of the world's turmeric crop and consumes the majority of it. Indian turmeric is the best in the world due to its inherent qualities and high content of the important bioactive compound curcumin.

In traditional medicine, it has been used as a home remedy for biliary disorders, anorexia, cough, diabetic sores, hepatic disorders, rheumatism and sinusitis. Scientists are researching curcumin, turmeric's active ingredient, for its antioxidant activity, anti-inflammatory properties, anti-metabolic syndrome activities, neuroprotective activity,

Raw turmeric achar

Value added products from Raw turmeric

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antimicrobial effects, anti-arthritis effects, anti-asthma, anti-obesity, cardio- and liver-toxicity protection activity, anti-depression and anxiety activities, anti-carcinogenic, anti-mutagenic, anticoagulant, anti-fertility activity, anti-diabetic, anti-fibrotic, anti-venom, anti-ulcer, hypotensive activities.

The turmeric, which is known for the nourishment and health,is used for the treatment of cold, cough, and sore throat Consumer interest in immunity-boosting products has recently increased amid the pandemic COVID-19 outbreak. One of the most popular immunity boosters in the world is turmeric. In addition to turmeric powder, raw turmeric rhizomes can also be used to prepare a number of tasty and healthy products for immunity-boosting. Raw turmeric achar, raw turmeric tea, naturally fermented turmeric soda, raw turmeric curry, raw turmeric halwa, raw turmeric chutney, fresh turmeric in brine, raw turmeric lozenges, raw turmeric panjiri, turmeric smootie, raw turmeric shots, and raw turmeric soup are the main value-added products from turmeric rhizomes.

Raw turmeric panjiri

Raw turmeric achar

Traditional Indian turmeric pickle has the potential to be a powerful immunity booster in addition to being delicious. Washing, peeling, and slicing into small pieces are all part of the procedure. Allow it to dry at room temperature overnight. In a pan, heat mustard oil and add methi seeds and rye; stir until well combined and cook for 10–20 seconds. Later, add turmeric slices to the pan and thoroughly mix; add salt and lemon juice to the above-prepared mixture. Finally, bottle it and cover it with a muslin cloth. Allow it to ferment in the sunlight for 7 days to produce the final product, a turmeric pickle.

Raw turmeric panjiri

It is a traditional North Indian healing food for pregnant women. Washing, peeling, and grating raw turmeric are all steps in the process of making panjiri. Coarsely grind the dry nuts viz.,

Raw turmeric halwa

Turmeric bug

almonds, cashews, raisins, and walnuts. Heat the oil in a pan and roast the grated turmeric, coconut and black pepper. Cook for 10–15 minutes on medium heat, or until the raw flavour has faded and the oil has separated. Remove the turmeric and set it aside. Make syrup with jaggery. Combine jaggery syrup and powdered dry nuts. Add roasted turmeric, coconut, and black pepper to the jaggery mixture. Combine thoroughly. Make round balls once the mixture has cooled.

Raw turmeric halwa

Wheat flour is golden brown in two tablespoons gheeand warmed. Cook for 5–7 minutes and set aside. Roast the turmeric in the remaining ghee for 10 minutes, or until the raw flavour has evaporated. Add the roasted wheat flour and mix well as the ghee separates. Add milk and stir to combine. Mix in the mashed jaggery thoroughly. Continue heating for 4–5 minutes, or until the

Raw turmeric tea

Naturally fermented turmeric soda

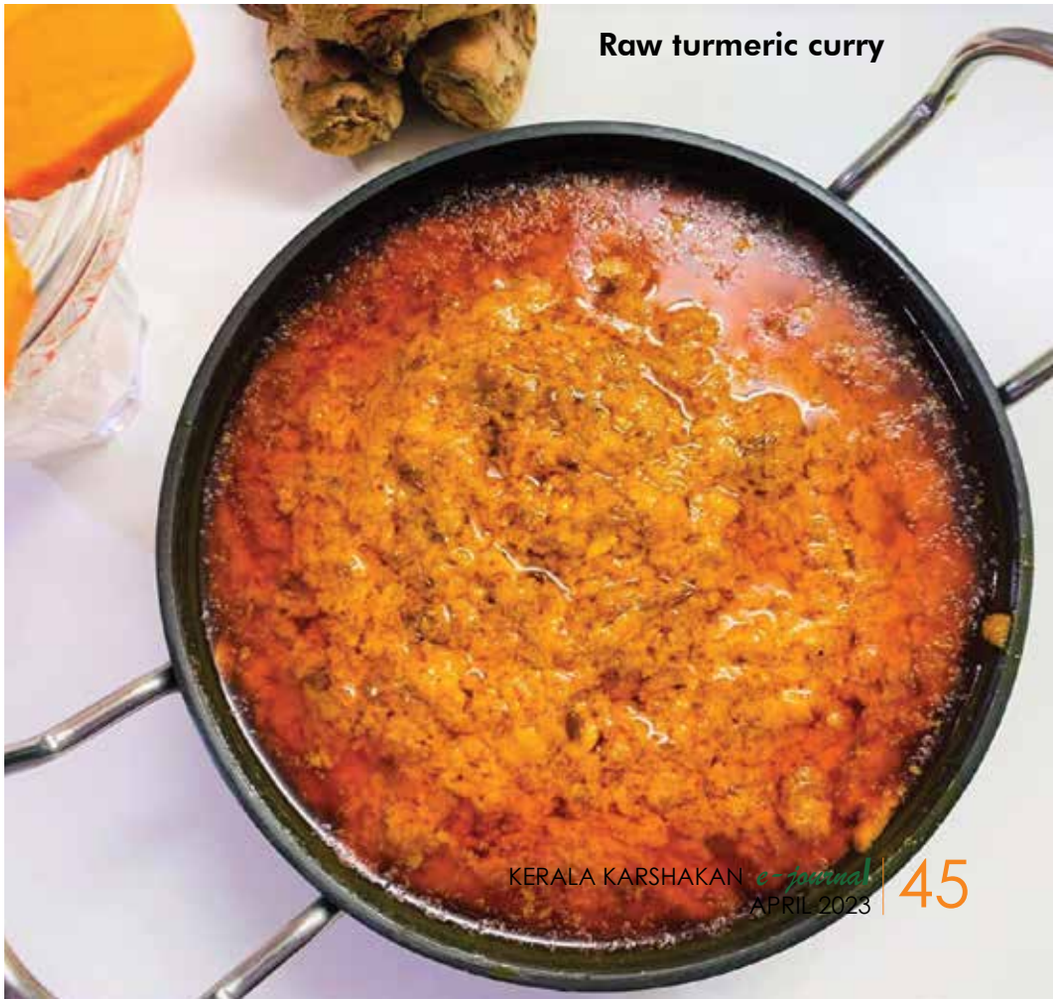
mixture is consistent and add dry fruits. Serve the turmeric halwa immediately.

Raw turmeric tea

For each cup of water, use about a 2-inch nub of turmeric. Simply cut the turmeric into thin rounds, about 14 inches in diameter or less. In a saucepan, combine the turmeric and water and gently simmer for 5 minutes before straining. We can add honey for sweetness.

Turmeric bug

It is a sweetened fermented turmeric inoculant made by washing and grating fresh turmeric rhizomes. In a mason jar, combine one tablespoon of grated turmeric and one teaspoon of sugar. To dissolve the sugar, add three



Raw turmeric curry

Raw turmeric chutney

tablespoons of water to the jar and stir well. Then, using a rubber band, secure a clean towel to the jar. Allow it to ferment for a few days. It is used as a starter for making of turmeric sodas.

Naturally fermented turmeric soda

It is a natural anti-inflammatory soda. Turmeric rhizomes, ginger, and pepper are boiled in water to prepare the soda. The strained liquid steamed and poured into a jar. The jar is filled with water, leaving inches of head space. Place the turmeric bug, which is a fermented, sweetened turmeric inoculant, in the jar. Cover the jar and leave it to ferment for 3–4 days. Once the turmeric soda is ready, strain out the turmeric pieces and refrigerate it for a few days to allow the carbonation to build up.

Raw turmeric curry

It is made by blending fresh turmeric rhizomes, ginger, coriander seeds, curry leaves, tomato, onion, tamarind, cumin, and other ingredients into a paste. To season, fry curry leaves in oil. Add the paste and boil until the oil floats to the top. Serve with rice and raw turmeric curry.

Raw turmeric chutney

It is a hot and tangy chutney. It goes well with dosa, idli, or hot rice. It is made by washing, peeling, and blending raw turmeric rhizomes and tomato puree. To season, fry curry leaves in oil. Cook until the oil floats to the top after adding the paste to the oil.

Fresh turmeric in brine

It involves preserving fresh turmeric rhizome pieces in cans filled with salt solutions. It is a preservation technique.

Raw turmeric lozenges

Boiling water is mixed with jaggery, turmeric powder, ginger juice, and black pepper. Bring the entire mixture to a rapid boil while stirring to dissolve. Maintain the TSS at 70 B. Drop test is used to determine the end point. When it reach a thick consistency, the burner

Fresh turmeric in brine

is immediately turned off, and lemon juice is added. Allow to set in butter paper or silicone moulds for 15-20 minutes.

Turmeric smootie

It is a delicious and healthy breakfast that can be made by blending fresh turmeric rhizomes with milk and any fruit, such as pineapple, mango, berries, and so on. It can be chilled and served cold.

Raw turmeric shots

Turmeric shots are healthy wellness shots that support our immune system. Crushed turmeric and crushed black pepper are added in warm water. Stirred thoroughly and supplemented with honey to enhance the taste.

Turmeric soup

It is made by sautéing onion, garlic, turmeric, ginger, and carrot in olive oil. Adding spices and vegetables to food gives it a savory taste. Blend it to broth. Before serving, squeeze the lemon.

Turmeric smootie

Turmeric soup

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