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1. AGRICULTURAL EXTENSION EDUCATION

Role of Livestock Extension in Sustainable Development of Farmers

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Introduction

Livestock agricultural contributed 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of rural community and it contributes 4.11% GDP and 25.6% of total Agriculture GDP. It also provides employment to about 8.8 % of the population in India. when compare other country we have largest livestock population in the world and we stands first in buffaloes population (108.7 million), Second cattle (190.9 million), and goat (135.2 million), Third sheep (65.1million), "Sustainability means improving resource efficiency, strengthening resilience and securing social equity/responsibility of agriculture and livestock food systems in order to ensure food security and nutrition for all, now and in the future." Even more importantly, livestock provides a major source of supplementary income for rural households and this sector is dependent on livestock therefore, highly livelihood intensive and more importantly provides sustenance during drought and other natural calamities to rural families

Livestock sustainability

Sustainable livestock production means making livestock systems economically more efficient and striking balance between meeting the growing demand of animal-origin products and reducing to the minimum the negative side effects and externalities from the livestock sector. Livestock are used for draught power, milk, meat, eggs, wool and increases soil fertility, livelihoods, etc and thus ensuring additional and continuous income to the livestock farmers. Livestock are the living bank for many farmers and have a critical role in the agricultural intensification process through provision of draught power and manure for fertilizer and fuel.

Role of Livestock Extension Services for Sustainability Farmers

Extension services are responsible for serving more than one billion small-scale farmers in the world the improvement of agricultural sciences and technology has brought about dramatic changes in the livestock sector in particular through improvement of animal health, breeding procedure and processes of animal products and improve Problem Identification and Potential Solutions

Detailed Work plans: Immediate objectives need to be prepared with detailed work plans. The workplan should detail manpower requirements, responsibilities and, at least at a rudimentary level, a critical path analysis to

identify crucial points in the programme. Simple recording of herd/flock dynamics (births, deaths, sales, purchases), estimates of milk yields, if applicable, and/or size/weight estimates, combined with local market information can produce valuable information of actual performance

Strengthening Livestock Extension: Pluralism in livestock extension services-Need of the hour, Effective coordination- public and private agencies, Encourage participation of private organizations/ NGOs./CSR initiatives etc.

Reducing knowledge gap of farmers: Only 5% households access information related to animal husbandry against 40 % of households accessing information on modern technology for crop farming, Gear up Public sector extension services information on modern technologies in livestock production, An effective extension machinery ad access to inputs ca improve productivity by adopting latest technology

Training cum Development: This is an approach develops in some its projects to facilitate livestock extension and development. The concept is to use a small, multi-disciplinary, task force within a selected area, to promote livestock production through a combination of training and development activities. It recognizes a number of important points

Emergence of Contract Farming and Resulting Privatization: Encouraging private investment and provision of foreign direct investment up to 51 % has resulted in entry of private players in poultry and dairy sectors. In poultry a high degree of privatization started from supply of day old chick to procurement of marketable broiler and selling to final consumer *i.e.* from hatchery to dinning concept

Improving Research-Extension linkages: Research outputs can be effectivelycommunicated by stronger linkages, Promotion of direct interface between farmers , officers of line departments and scientists, Research priority setting by SREP based on PRA and joint study of teams including line depts. officials and scientists of the KVKs or Universities, Participatory Technology Development can connect farmers with the scientists leading to need based researches.

Crop-based and animal health-based extension: The importance of livestock to household welfare, fertility maintenance and production is still under-recognized in many developing countries. But livestock production extension faces the additional institutional problem of being marginal to both agricultural extension and animal health services. Agricultural extension services have mainly focus on crop production, and remain tied largely depends on seasonal nature of cropping. Such a system is less useful for livestock production, with a longer time-scale and a lack of synchronization of different animals and herds.

Role of Agricultural subject matter Specialists:

- Veterinarians can be supported by Agricultural officers for knowledge and inputs about agronomy.
- Model successful in the state of Punjab to make aware about feeding of crop residues; vegetable or fruit wastes etc. with such programmes.
- Farmers' training and Farmer led approach:
- Based on participatory mode depending on socio economic background of the farmers.
- Progressive farmers after various scientific orientation can be encouraged to act as extension agent

Gender and Livestock Extension:

- Need for matching programmes and budgeting for women.
- Women Extension workers must be promoted both in formal and informal mode.
- Group mobilization approach-
- Leading women farmers may be trained for transfer of technologies and deployed as women extension functionaries

ICT: Changing face of Extension: Increase effectiveness and efficiency of extension and help farmers to utilize information in solving their problems. Information can be acquired,

transmitted and used based on the need and situations Promotion campaigns for adoption of technologies and practices like AI, vaccination, concentrate mixture feeding etc. Interaction through Information Kiosks, Telecentres, toll-free Call Centres, websites, mobile phones software applications *etc*. New advanced instruments like Personal Digital Assistants for Extension agents for technical information, communicating, field recording, database maintenance and scheduling

Market Driven Approach: Production and marketing of livestock products. Need to create basic market facilities and market information. Promotion of sheep/poultry associations. Interface meet between input dealers/companies/certification agencies (feed, milking machine, etc.*)* with farmers

New interventions & Deliverables

- Community managed A. I. centers
- A.I. service at village level
- Fodder production and utilization
- Demonstration of fodder plots & azolla unit
- Fodder production and introduction of chaff cutter
- Animal health care service
- Livestock shows/ Exhibitions/ Campaigns

Conclusion

There is huge demand in the milk and milk additives in the market so we need to develop quality human power effective utilization of resource and infrastructure for dissemination the grass root level functionaries must be promoted to perform extension relevant activities rather than multiple tasks. ICT, PPP, and Farmer Led Extension help in how much to produces and when to tell and where to sell of activates and Farmers Associations can be most suitable solutions. In order to be optimal, livestock systems need updates to the modern requisite experts' opinion is necessary gaining of knowledge with policies that define and shape sustainable livestock development from a social, economic and environmental perspective.

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2. PLANT PATHOLOGY

Plant Products in Post-Harvest Disease Management

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Disease control with conventional chemical compounds carries the risk of resistance development by new pathogen races. Large numbers of synthetic chemicals are being used for the management of plant diseases. However, due to the development of new physiological races of pathogens, many of these synthetic chemicals are gradually become ineffective. Recently, in different parts of the world, attention has been paid towards exploitation of higher plant products as novel chemo therapeutants in plant protection. The popularity of botanical pesticides is once again increasing and some plant products are being used globally as green pesticides.

Natural plant products

"Some plant contains components that are toxic to pathogens, when extracted from the plant and applied on infested crops, these components are called natural plant products or botanical pesticides or botanicals"

- Plant extracts
- Natural oils (Volatile / Essential oil)
- Plant derived antimicrobial secondary metabolites
- Plant based Gel and Latex

Plant extracts

The natural products derived from plants have proven to be an abundant source of biologically active compounds, many of which have been the basis for the development of new lead bio chemicals for disease mangement. With respect to diseases caused by microorganisms, the increasing resistance in many common pathogens to currently used therapeutic agents, such as fungicides and chemicals, has led to renewed interest in the discovery of novel anti-infective compounds. Some of the plant products, which are effectively used for plant disease management, are listed below

Neem	*(Azadirachta indica)*	Ginger	(Zingiber offi-cinale)
Garlic	*(Allium sativum)*	Turmeric	(Curcuma Longa)
Eucalyptus	*(Eucalyptus globulus)*	Pepper	(Piper nigrum)
Black nightshade	*(Solanum nigrum)*	Tulsi	(Ocimum gratissimum)
Periwinkle	*(Vinca roseus)*	Guava	(Psidium guajava)
Chaste tree	*(Vitex nigundo)*	Wood apple	(Aegle mormelos)

Plant derived antimicrobial secondary metabolites

Secondary metabolites show antimicrobial effect and serves as plant defense mechanisms against pathogenic microorganisms. Plants have limitless ability to synthesize aromatic secondary metabolites, most of which are phenols or their oxygen-substituted derivatives, show antimicrobial effect and serves as plant defense mechanisms against pathogenic microorganisms. Important subcla- sses in this group of compounds are listed below,

- **Simple phenols and phenolic acid** are bioac-tive phytochemicals consisting a single substituted phe-nolic ring. Phenolic toxicity to microorganisms is due to the site(s) and number of hydroxyl groups present in the phenolic compound.
- **Quinones** are characteristically highly reactive, colored compounds with two ketone substitu-tions in aromatic ring.
- **Flavones, flavonoids and fla-vonols** are phenolic structure with one carbonyl group. They are synthesized by plants in response to microbial infection and are often found effective in vitro as antim-icrobial substance against a wide array of microorgan-isms.
- **Tannins** are polymeric phenolic sub-stances possessing the astringent property. These com-pounds are soluble in water, alcohol and acetone and give precipitates with proteins.
- **Coumarins** are phenolic substances made of fused benzene and α-pyrone rings. The crude sap, volatile and essential oil extracted from whole plant or specialised plant parts like roots, stem, leaves, flowers, fruits and seeds are widely used in pre-paring the antimicrobial compounds against the different plant pathogens/diseases

Essential / Volatile oils

Essential oils are made up of many different volatile compounds.The composition of the oil quite often varies between species. Essential oils possess antimicrobial and antifungal properties. The main role of essential oil is plant defense mechanisms against Phytopathogenic microorganisms. Alternative to fungicides. The potential essential oils used widely against post harvest pathogens. They are Terpenoides and aromatic compounds in nature."Volatiles are small molecular weight organic com-pounds having appreciable vapour pressure at ambi-ent temperature"

Examples

Black pepper (*Piper nigrum* Linn.), Clove (*Syzygium aromaticum* Linn.) Nutmeg (*Myristica*	Eucalyptus oil (*Eucalyptus globules*), Rue oil (*Ruta graveolens* Linn.), Lemon grass oil

fragrans Houtt.), Oregano (*Origanum vulgare* Linn.)	Thyme (*Thymus vulgaris* Linn.)

Plant Based Gel

Gel derived from Aloe vera plants has been found to be effective against grape pathogen (*Penicillium digitatum*, *Penicillium expansum*, *Botrytis cinerea*, *Alternaria alternate)*.Aloe vera (AV) is a short-stemmed succulent plant species belonging to the Asphodeleceae (Liliaceae) family. The AV plant stem has a high tendency to survive in severe circumstances because it can retain moisture in warm and dry climates. For centuries, many traditions and cultures have used AV for medicinal purposes. AV gel inhibits the growth of various pathogenic and foodborne spoilage organisms. Moreover, AV gel coatings reduced O_2 consumption and CO_2 production, thereby preventing anaerobic conditions. So it has great anti-browning and antimicrobial effects and is used as an additive in the formulation of edible coatings.

Plant Based Latex

Plant based Latex is a natural fungicide. They are Safe and effective against various diseases of banana, papaya and other fruits. Water-soluble fraction of papaya latex against post harvest pathogens. Hevein was isolated from the latex of the rubber tree (Hevea brasiliensis) for control of *Botrytis cinerea* fungal pathogen.

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3. HORTICULTURE: SPICES

Application of Molecular Markers in Spice Crops

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Introduction

Spices and condiments are the integral part of Indian cooking. They have been used since ancient times. Spices were mentioned in the ancient Hindu scriptures. India holds rich source of valuable spice germplasms. Huge genetic diversity in spices speeds up rapid and diverse genetic advancement in yield and yield attributing traits. Genetic improvement in spices is a continue process to increase the yield and quality. There are numerous number of improved cultivars in spices developed through conventional approaches and in recent year's molecular breeding approaches strengthening the yield and quality improvement in spices accordingly. Conventional plant breeding can be considered as the crop improvement procedures which are practiced over a long period of time without involving recent high throughput molecular approaches. Changing the genetic makeup of plants for the betterment of their economic use. But to assure both food and nutritional security, it became mandatory to extend the areas of conventional breeding methods and inclusion of modern genomics and molecular markers. In this regard it is spectacular to note that, the era of plant biotechnology began in 1980s and molecular marker systems were developed and applied by that time to utilize the association of genetic linkage between markers and economic traits of crop plants.

Marker

Definition: The traits which can be easily identified are referred to as marker characters

A genetic marker is a gene or DNA sequence with a known location on a chromosome and associated with a particular gene or trait.

- It may contain some information which is specific in nature and desirable trait

- It can be described as a variation, which may arise due to mutation or alteration in the genomic loci that can be observed

Why Markers???

- Deducing genetic divergence and interrelationships at DNA level among individuals
- Free from the environmental influences
- Increases favorable gene action
- Efficiency of selection
- Characterization of genetic divergence - genetic fidelity and identification genes of economic interests
- Improvement *via* genetic transformation system in crop plants

Applications of molecular markers

- Molecular markers are very useful in identification of plant varieties.
- Can be used for DNA fingerprinting, gene tagging and gene mapping
- For identification of resistant plants it can be used in breeding
- Two to three backcross with Marker Aided Back cross Selection
- Useful in gene pyramiding that is bringing two or more different genes conferring resistance to same pathogen in same line/ variety.

Markers used in Spice Crops

Spice	Markers used	Purpose
Black pepper	Microsatelite EST&SSR RAPD	Examining genetic diversity
Cardamom	ISSR,RAPD&RFLP	Examining genetic diversity
Turmeric	SSR/ISSR	Examining genetic diversity
Ginger	ISSR&SSR RAPD	Examining genetic diversity Variability in somaclones
Chilli Paprika	RAPD	Examining genetic diversity

Markers used against biotic stress resistance in spices

Spice	Markers used	Purpose
Black pepper	SCAR	Phytophthora resistance
Cardamom	RAPD	Associated with katte resistance
Ginger	RAPD	Wilt resistance
Turmeric	ISSR	Nematode resistance

Markers used for sex identification in spices

Spice	Markers used	Purpose
Nutmeg	SCAR	Associated with dioecious nature
Betelvine	SCAR	Associated with dioecious nature

Role of markers in detection of adulteration in spices

Adulteration is illegal as the consumption of adulterated products containing undeclared or unlabeled constituents may cause intoxication, allergies, or other undesirable side effects.

- A food adulterant may be defined as any material which is added to food or any substance which adversely affects the nature, substance and quality of the food.

Detecting adulteration is a prerequisite to food safety also. Adulteration has been reported in commercially sold turmeric powder, adversely affecting the quality of the product and its trade. Protein-based methods such as immunological assays, electrophoretic, and chromatographic techniques such as TLC and HPLC require fresh samples. Also, the results of these methods are less reliable because the composition of the same product from different manufacturers varies substantially. With highly processed items, the

methods are not sensitive enough. Routine DNA-based methods such as RAPD, SCAR, and SSR/SNPs suffer from the lack of uniformity and inadequate standardization. These problems have prompted the development of broadly accessible commercial tools such as DNA barcoding to detect product substitution and to authenticate commercial products.

Spices	Adulterant	Disease/disorder
Chilli	Brickpowder Lead soluble salts Oil soluble tar Rodamine B	Stomach disorder Metal toxicity, Cancer, Lead poisoning Heart disease, damage to liver, tumor Cancer
Turmeric	Aniline dye, Yellow lead salts , Metanil Yellow Tapioca starch	Cancer Stomach disorder
Coriander powder	Common salt Dung	High blood pressure Stomach problem

Examples of molecular approaches for quality evaluation of spices

Spices	Markers	Adulterant
Red chilli	RAPD	Plant based adulterants like dried red beet pulp, almond shell dust and powdered Jharber (*Ziziphus nummularia*) fruits
Saffron	SCAR IISR (PCR)-based assay	Flowers of Mountain arnica 1%, English marigold, safflower (*Carthamus tinctorius* L.), spring crocus (Crocus vernus L. (Hill)), day lily (*Hemerocallis* sp.) and rhizomes of turmeric.
Black pepper	SCAR	Fruits Papaya seed (*Carica papaya* L.)
Turmeric	SCAR	Other Curcuma species like (*C. zedoaria* and *C. malabarica*)
Cinnamon -	(PCR)-based assay	Inferior species like *C. cassia* and *C. malabatrum*

Conclusion

Because of their commercial importance, intensification of biotechnological approaches in spice breeding are essential in the coming decade. Use of molecular markers for genetic characterization of germplasm as well as plant varieties need to be given priority. This also helps in developing finger prints and diagnostic markers for varietal identification which will be very useful in certification of planting materials. Development of high density molecular maps and gene tagging will help in MAS and reducing breeding time especially in perennials. Application of recombinant DNA technology for production of resistant types to biotic and abiotic stress has to go a long way before they can be effectively used in spices improvement. High throughput molecular breeding combined with conventional breeding approaches will make spice genetic improvement steadier.

Future prospects

- QTL mapping may be combined with breeding facilitating conversion of basic research into an applied endeavour.
- MAS will be extremely effective in facilitating transfer of transgenes by accurate tracking in segregating generations.
- Development of high density molecular maps and gene tagging will help in MAS and reducing breeding time especially in perennials.
- Application of recombinant DNA technology for production of resistant types to biotic and abiotic stress

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4. SOIL SCIENCE

Role of Ion Exchange in Soil Fertility

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Ion exchange takes place in soil colloids. The phenomena of ion exchange is of great importance in agriculture.Ion exchange has influence on the absorption and release of the nutrients in soil. Ion exchange controls soil structure and crumb formation.It also helps in maintaining the structural stability of the soil.

Ion exchange also plays important role in the reclamation of problem soils particularly acid and alkali soils.

There are two types of ion exchange.

1. Cation exchange
2. Anion exchange

Cation exchange capacity (CEC):

The CEC is the capacity of soil to hold and exchange cations. The cation exchange capacity is defined simply as the sum total of the exchangeable cations that a soil can adsorb.Cation exchange capacity is considered to be the second most important reaction in the universe next to photosynthesis.

Replacing power of cations: The replacing power of cations varies with the type of ion, it's size and degree of hydration, valence and concentration and the kind of clay mineral involved.

The cation exchange capacity is expressed in terms of equivalents or more specifically, as milli equivalents per 100 gram and is written as meq /100g. The newer metric system, it can be written as c mol (+) kg^{-1} of soil (centimoles).

Factors affecting Cation Exchange Capacity:

Cation exchange capacity (CEC) is decided by 1. Soil texture, 2. Organic matter and 3. Soil rexction (pH)

1. **Soil texture:** Fine textured soil (Clay) has high CEC than coarse textured soils (Sand). The clay minerals present in clay soil usually have high CEC..eg.Montmorillonite – 80 to 120 meq/100 g. Vermiculite – 100 to 200 meq/100 g kg^{-1}. Whereas clay minerals present in sandy soils *viz., K*aolinite has a CEC of 3 to 15 Meq/100 g and Illite has a CEC of 20 to 40 meq/100 g . A high-clay soil can hold more exchangeable cations than a low-clay soil.

   Clay minerals usually range from 10 to 150 meq/100 g in CEC values. So, the kind and amount of clay and organic matter content greatly influence the CEC of soils. Clay soils with high CEC can retain large amounts of cations against potential loss by leaching. Sandy soils, with low CEC, retain smaller quantities. This makes timing and application rates important in planning a fertilizer programme. For example, it may not be wise to apply K on very sandy soils in the middle of a monsoon, where rainfall can be high and intense. Fertilizer application should be split to prevent leaching and losses through erosion. Also, splitting N applications to meet peak crop demand are important to reduce the potential for nitrate leaching on sands as well as finer-textured soils.
2. **Soil organic matter:** CEC also increases as organic matter increases.High organic matter content in a soil has higher CEC. Organic matter ranges from 200 to 400 Meq/100 g.
3. **Soil reaction (pH):** Cation exchange capacity of most soils increase with pH of the soil.At low pH values the CEC also is low. As the pH is increased, the negative charges on

some 1 : 1 type clay minerals (kaolinite), humus and Fe and Al oxides increases thereby increasing the CEC.

Cation exchange and soil fertility :

By cation exchange, hydrogen ions from the root hairs and micro organisms replace nutrient cations from the exchange complex, thereby increasing the soil fertility.

Soil with high calcium has good physical and nutritional condition. A calcium dominated soil is granular in structure and porous in nature, ensuring good drainage.

Cation exchange capacity also helps in preventing the loss of nutrients by leaching. Cation exchange helps in holding the cations like Ca, Mg, K and NH_4 on the colloidal surfaces and are readily available to the plants.

Influence of complementary adsorbed cations on soil fertility

The strength of adsorption, when the ions are present in equivalent quantities are as follows.

$Al^{3+} > Ca^{2+} > Mg^{2+} > K^{+} = NH_4^{+} > Na$

Anion exchange

The other ion exchange process which is similar to cation exchange is Anion exchange. Clay colloids become positively charged due to the addition of H^+ and OH^- resulting in net positive charge (OH_2^+). The capacity of holding anions increases with the increase in acidity. $H_2PO_4^-$ is adsorbed in acid soil. Adsorption of negative ion (anions) e.g. Cl^-, $NO3^-$ $SO4^{2-}$ and $H_2PO_4^-$on positively charged sites of clay and organic matter is known as anion adsorption.

The basic principles of cation exchange apply as well to anion exchange, except that the charges on the colloids are positive and the exchange is among negatively charged anions.A simple example of an anion exchange reaction is

Micelle NO_3^- + Cl^- ---------- Micelle Cl^- + NO_3

(Soil solid) (In soil solution) (Soil solid) (In soil solution)

Sources of positive charge

1. 1. Isomorphous substitution: Low valency cations replaced by high valency cations.
2. 2. Surface and exposed broken bonds of clay lattice: OH group in certain acid soils.
3. 3. Complex aluminium and iron hydroxy ions in acid soils.
4. 4. pH dependent charges are important for anion exchange of organic matter

Importance of anion exchange: The phenomenon of anion exchange assumes importance in relation to phosphate ions and their fixation. The exchange is brought about mainly by the replacement of OH ions of the clay mineral. The reaction is very similar to cation exchange.

OH - Clay + H_2PO_4 ------- H_2PO_4 - Clay + OH^-

The adsorption of phosphate ions by clay particles from soil solution reduces its availability to plants. This is known as phosphate fixation. As the reaction is reversible, the phosphate ions again become available when they are replaced by OH ions released by substances like lime applied to soil to correct soil acidity. The fixation is temporary. The whole of the phosphate adsorbed by clay is, however, not exchangeable, as even at pH, 7.0 and above. So, substantial quantities of phosphate ions are still retained by clay particles. The OH ions originate not only from silicate clay minerals but also from hydrous oxides of iron and aluminium present in the soil.

The phosphate ions, therefore, react with the hydrous oxides also and get fixed as in the case of silicate clay, forming insoluble hydroxy - phosphates of iron and aluminium.

$Al(OH)_3 + H_2PO_4$ --$Al(OH)_2 . H_2PO_4 + OH^-$

(Soluble) (Insoluble)

If the reaction takes place under conditions of slight acidity it is reversible, and soluble phosphate is again liberated when hydroxy phosphate comes in contact with ions. If the reaction takes place at a low pH under strongly acid conditions, the phosphate (ions) are irreversibly fixed and are totally unavailable for the use of plants.

Thus ion exchange of both cation exchange and anion exchange play an important role in enhancing the fertility status of the soil.

5. HORTICULTURE

Fennel (*Foenoculum vulgare* Mill.): A Seed Spice as a

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Medicine.

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The secrets of health of our ancestors can be found in the humblest ingredients in the kitchen. Saunf seeds is one such wonderful ingredient imbued with dense nutrients that we need to reveal them. Saunf or fennel, the aromatic spice needs no special mention as it is one of the prominent spice used extensively for its indispensable medicinal and culinary practices in India.

India is known as the "'Land of Spices" and largest producer, consumer and exporter of seed spices and their products in the world. Fennel (*Foeniculum vulgare* Mill), 2n=22 an important open cross-pollinated crop, belong to family *Apiaceae* and is mainly grown in temperate and subtropical regions for seeds. It has originated from Mediterranean region, where its high degree of genetic variability persists. Fennel seeds are popularly clad across different parts of the country as Saunf in Hindi, sompu in Telugu, peruncirakam in Tamil, perunjirakam in Malayalam and mauri in Bengali.

In Ayurveda, fennel seeds are considered very auspicious. They were extensively used in various recipes in ancient India. The age-old secrets of health can be found in the simplest ingredients in our kitchens. We just need to unveil them.

In India, fennel seeds are quite popular among people as the seeds can miraculously treat an endless list of digestive ailments that include colic in infants, intestinal gas, heartburn, and more. You can even use the seeds as a mouth freshener after you have a hearty meal. Hence, we can see that fennel seeds offer a wide range of benefits that makes it very popular among people. So, the next time you're thinking of incorporating a food item into your diet with multiple health benefits, you should consider fennel seeds as they would fit in perfectly with your long term or short term health goals.

Nutritional Facts:

Dried fennel or saunf is a storehouse of vital nutrients, low on calories and abundant in vitamin C fennel seeds bolsters the immune system, stimulates the collagen production and works as a potent antioxidant that scavenges the free radicals. Rich in manganese fennel seeds activates the enzymes, triggers metabolism, regulates blood sugar and strengthens the bones. Besides these, a notable amount of iron, calcium, magnesium, potassium and selenium promotes skin health, controls blood pressure and treats anemia.

Fennel seeds also comprise more than 87 volatile compounds including polyphenol antioxidants such as anethol, rosmarinic acid, chlorogenic acid, quercetin, apigenin *etc.*, Several studies have disclosed that a diet rich in antioxidants lowers the risk of chronic diseases

Nutritional value per 100g (Source: USDA National Nutrient data base)

Principle	Nutrient value	Percentage of RDA
Energy	345 Kcal	17 %
Carbohydrates	52.29 g	40 %
Proteins	15.80 g	28 %
Total fat	14.87 g	48 %
Cholesterol	0 mg	0 %
Dietary fiber	39.8 g	104 %
Vitamins		
Niacin	6.050 mg	37 %
Pyridoxine	0.470 mg	36 %
Riboflavin	0.353 mg	28 %
Thiamin	0.408 mg	34 %
Vitamin A	135 IU	4.5 %
Vitamin C	21 mg	35 %
Electrolytes		
Sodium	88 mg	6 %
Potassium	1649 mg	36 %
Minerals		
Calcium	1196 mg	120 %
Copper	1.067 mg	118 %
Iron	18.54 mg	232 %
Magnesium	385 mg	96 %
Manganese	6.533 mg	284 %
Phosphorus	487 mg	70 %

Zinc	3.70 mg	33.5 %

Health Benefits of Fennel (*Foeniculum vulgare*)

Some of the health benefits of fennel are as follows:

1. **Chewing raw seeds combats bad breath:** Fennel seeds contain a specific aromatic essential oil that possesses antibacterial properties that help to freshen your breath. The sweet fennel seeds increase the secretion of saliva, which helps to kill the harmful bacteria. It is a simple and effective home remedy to combat bad breath. Munching on 5 to 10 fennel seeds could freshen your breath.
2. **Improves digestive health:** The goodness of fennel seed essential oils stimulates the secretion of digestive juices and enzymes that improves your digestion. Fennel seeds contain anethole, fenchone and estragole that act as antispasmodic and anti-inflammatory. They work wonderfully for constipation, indigestion and bloating. For better results, consume fennel tea to keep your digestive tract healthy and happy. Fennel seeds also contain fibre and while they may be small in size their fibre content is high. This can further improve your digestive health. By improving the fibre levels in your diet, fennel seeds contribute to better heart health as numerous studies have linked higher fibre diets with a lower risk of cardiac diseases.
3. **Helps to regulate blood pressure:** Fennel seeds are rich in potassium that regulates the fluid amount in the bloodstream. It helps to control your heart rate and blood pressure. As per the published study, fennel seeds increase the level of nitrite in the saliva. Nitrite is a natural element that keeps a check on blood pressure levels.
4. **Reduces asthma and other respiratory ailments:** The high number of phytonutrients present in fennel seeds helps to clear sinuses. These tiny seeds offer bronchial relaxation that helps to reduce symptoms of asthma, bronchitis and congestion.
5. **Promotes lactation:** Anethole present in fennel seeds stimulates the galactagogues (substances that promote lactation) to increase milk secretion. Many studies suggest that anethole mimics the action of the estrogen hormone and promotes lactation.
6. **Improves skin appearance:** Fennel extract works miraculously for the skin by protecting it from free radical damage and improving skin cell longevity. They are abundant in minerals such as potassium, selenium and zinc. These minerals are crucial for balancing hormones while maintaining the oxygen balance in your bloodstream. They are widely used to treat different skin ailments like acne, rashes and dryness.
7. **Purifies blood:** The essential oils and fibers in fennel seeds help to purify your blood and flush out the toxic compounds out of your body.
8. **Keeps cancer at bay:** Many studies suggest that fennel seeds have anti-cancerous properties. They have powerful antioxidant properties that neutralize free radicals and beat oxidative stress. It may be the reason that prevents the development of cancer.
9. **Helps to improve eyesight:** A handful of fennel seeds can do wonders for your eyes. It contains vitamin A that is an essential vitamin for the eyes. Earlier, fennel seed extract was useful to treat glaucoma.
10. **Promotes weight loss:** Fennel seeds are a rich source of fiber which helps you feel full for longer, thus preventing you from overeating. This results in consumption of lesser calories and ultimately aids weight loss. Consumption of fennel seeds may also help reduce fat storage by improving the nutrient-absorption in the body. Additionally, with the presence of antioxidants like zeaxanthin, lutein, beta-carotene, chlorine, manganese, zinc, selenium, phosphorus, and more that are known for protecting the body against oxidative stress and improving the metabolic rate of a human body. And also help in improving the body's absorption power for vitamins and minerals. Another advantage of the antioxidants is that they help in breaking down the fats and carbs in the body, helping

you in avoid gaining extra pounds. This spice also has diuretic properties. Hence, consuming it in its liquid form (fennel tea) can help increase the flow of urine and remove toxins from the body, resulting in effective weight

11. **Reduces Gas:** Due to its excellent digestive properties, as well as the fact that it is antimicrobial, fennel seeds are thought to aid in reducing gas. By improving digestive movement, this seed allows easy passage of bowels without excessive gas build-up. And with its antimicrobial effect (mainly from the anethole, an organic compound in the seed) it prevents bacteria from growing and releasing gases in the first place.

Conclusion

In India, fennel seeds are quite popular among people as the seeds can miraculously treat an endless list of digestive ailments. It is storehouse of antioxidants and volatile oils which has the potential to improve heart health, lessen inflammation, stimulate digestion and promote weight loss. To reap the wellness incentives of this amazing herb, incorporate dried fennel seeds in your daily regimen.

6. AGRONOMY

Cultivation of Opium Poppy in India

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Introduction

The opium poppy, how, when and its produce came to the Indian people is uncertain. In the book named Ain-i-Akbari (Administration of Akbar) compiled by SheikhAbulFazal in 1590 A.D, the poppy is mentioned as a staple crop of the spring harvest of then Subhas of Agra, Oudh and Allahabad. Instructions to make opium as part of investment were first issued by the East India Company in A.D.1683.In India the opium monopoly was promulgated by the Opium Act of 1857 (Act no. XII of 1857), the monopoly of manufactured drugs was established by the Opium Act 1878 and Dangerous drugs Act of 1930. Then in India January 1950, the control over the cultivation and manufacture of opium throughout India was passed into the hands of the Government of India on April 1, 1950. The Opium and Revenue Laws (Extension of Application) Act, 1950, No. XXXIII of 1950, the three Central Government enactments viz., the Opium Act of 1857, the Opium Act of 1878 and the Dangerous Drugs Act of 1930, now apply uniformly in all the States of the Indian Union. The All India Narcotics Board was established by Resolution No. F.235-E.0/45 of The Ministry of Finance of April 2, 1949. The government of India took 1st step in 1950 November in a programme to unify and rationalize the system of control over the production of opium throughout the country. The Department is now controlled by the Narcotics Commissioner, Government of India and the cultivation is carried on behalf of the Government.

Procedures

Licences are issued annually for a crop year which commences from 1st October and ends on 30th September of the following year. Central Bureau of Norcotics issues licences to eligible cultivators for licit cultivation in these notified tracts in October every year. The cultivators are required to tender their entire production to the Government, the Central Government announces a Minimum Qualifying Yield of a certain number of kilograms of opium per hectare. In India, opium poppy cultivation is prohibited, under Section 8 of the NDPS Act, 1985. At present, licit opium poppy cultivation is permitted by the Govt. of India in selected tracts of three traditionally opium-growing states namely Madhya Pradesh, Uttar Pradesh and Rajasthan.

General Conditions relating to grant of licence notified by the Central Government

The licence for the cultivation of opium poppy is granted by the District Opium Officer on

receipt payment fee of Rs.25/- only. The Settlement Operation is held in the month of October-November every year. The districtOpium Officer also appoints a Lambardar on such terms and conditions as have been specified by the Narcotics Commissioner, from a panel of five highest-yielding cultivators in a village. A cultivator wise Joint Licence for the village is also issued.

- The Central Bureau officers start exercising statutory control at the end of December each year. They will measure every field to check excess cultivation than the licensed area and it is conducted by the sub-inspector with the help of one Sepoy. The condonable limit in respect of excess in cultivated area shall not exceed 5%. If the Measured are exceeding 5% then it is reported immediately to the District Opium Officer of the Division and the concerned unit Deputy Narcotics Commissioner. The Deputy Narcotics Commissioner orders re-measurement of all such excess cultivation cases by deputing a gazetted officer and a 'Panchnama' in all such cases is drawn. In case the test-measured area exceeds 5% of the licensed area, action under the NDPS Act, 1985 is initiated against such cultivator by the unit Deputy Narcotics Commissioner.
- Opium crops may be damaged or suffered due to natural calamities like rain, hailstorm and diseases. If such damage occurs before lancing the capsules and post lacing, then those cultivators are allowed to get their unlanced damaged crop uprooted under departmental supervision. Uprooting cannot be done once the lacing has commenced in a particular plot but only partial uprooting is permitted, not in patches.
- The opium capsule is ready in the month of February-March for lancing or extraction of Opium by incision of the Opium capsule. The oozed out latex is collected daily and its weight is recorded in a register called PWR maintained by the Village Lambarder and the entries are periodically checked by the CBN officer. The variation between the quantity of opium produced by the cultivator indicated in the Lambardar's record and as found by the proper officer during his check, shall be inquired into by the proper officer to ascertain the liability of the cultivator for punishment under Section 19 of the NDPS Act, 1985. At the end of March, almost the collection of opium from the plants will be over and the CBN sets up procurement centres also known as Weighment Centres for the collection of this opium.
- When the opium is tendered, two very small samples are taken for (i) Hot Air Oven testing; (ii) For testing the presence of sugar, starch & gum etc. Basically in the oven method, the small drawn sample from each cultivator is heated to evaporate the moisture. After the examination and oven testing, the opium grade is classified by the District opium officer as per the consistency of opium and the class is announced publically.
- After weighing the class-wise opium the quantity of the opium tendered by the cultivator is converted into quantity at standard consistence i.e.70°C and 90% payment to the cultivators is made at the spot itself. The good opium is sent to the Government factory and tested again by the chemical staff then the classification of opium is determined and final payment to a cultivator is calculated. Accordingly either the balance payment is made to the cultivator or in case of down-gradation the excess amount is recovered from cultivators. If the cultivator is dissatisfied with the classification of opium done by the district opium Officer he may have it forwarded to the Govt Opium Factory separately under the supervision of the district opium officer.
- The sealed container of opium so received in the factory is opened and a

sample for test is drawn thereof in the presence of the cultivator, if he so desires, to whom, a notice intimating the date and time in this behalf is sent well in advance. Opium of each cultivator is dispatched to the opium factory separately in the plastic containers of 20 kgs or 35 kgs capacity as the case may be. The opium so procured is sent to the Government Opium and Alkaloid Factories situated at Neemuch and Ghazipur.

Conclusion

According to poppy straw section 15, poppy and opium section18, Cannabis - section 20, coca plants and leaves - section 16 cultivation or growing opium poppy may lead to Rigorous imprisonment up to 10 years and fine up to Rs. 1. Lakh. So before going for the cultivation of Opium Poppy the respected person should follow the proper Norms given by the Narcotics department and the Government of India.

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7. GENETICS AND PLANT BREEDING

Biotechnological Approaches for Understanding *bt* Resistance Development in Insects

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Introduction:

Genetically modified crops with *Bacillus thuringiensis* Cry toxins have been planted all over the globe to get rid of a major pest. For more than 20 years, the majority of *Bt* crop target pests have been managed in a sustainable and successful manner, owing to the execution of proactive resistance management techniques such as the high dose and refuge strategy, pyramid strategy etc. in several countries. However, there have been many instances of field-evolved resistance, which has resulted in reduced field efficacy. As a consequence, the emergence of resistance in target pests imposes a great concern to the continual success of *Bacillus thuringiensis* crops. It is essential to utilise sensitive detecting techniques to track the development of resistance in target insects and as a consequence, modify resistance management strategies ahead of time to prevent resistance from spreading. Various genetic options are there for target insects to deal with *Bacillus thuringiensis* crops are challenging the efforts to comprehend the mechanisms of resistance and to design rational resistance management approaches. The molecular genetic basis of *Bt* resistance must be identified in order to develop sensitive resistance detection and intelligent resistance management techniques.

Target pest resistance mechanisms to Bacillus thuringiensis crops

1. **Alteration in toxin activation:** Variations in the midgut protease composition are associated with a significant reduction in protoxin activation in *Bt*-resistant strains. At the point when the soluble serine protease activity of resistant and sensitive strains was analysed, the protease activity in sensitive strain was higher than resistance one Yidong Wu. (2014). *Plodia interpunctella*, a *Bt*-resistant strain, lacked major intestinal trypsin in its midgut. So that, the protoxin didn't activate in the insect midgut, which brought about *Bt* resistance. Cotton bollworms with mutations in the trypsin promotor gene were found resistant to Cry1Ac.
2. **Mutation in the toxin receptors**
3. **Cadherin:** CAD is a key *Bt* toxin receptor.

Cadherins are cell-surface proteins that help activated Cry toxins to oligomerize and for binding to ABC transporters. In several insect pests, *Bt* resistance is linked to a mutation in a cadherin gene. Cry toxin resistance is linked to gene disruption caused by retrotransposon-mediated insertion in the gene and a formation of an early stop codon. Morin *et al.* discovered three mutant alleles of the cadherin encoding gene that were linked to Cry1Ac resistance in *Pectinophora gossypiella*. A deletion linked with Cry1Ac binding was found in all the three Cry1Ac resistance alleles. The amino acids Leucine-1425 as well as Phenylalanine-1429 plays a crucial role in the interaction between cadherin and Cry toxin; if these amino acids are substituted by another charged amino acids, the toxin will not bind to cadherin, which brings about Cry toxin resistance. The primary events that cause this cadherin receptor to be modified are truncation, deletion, and amino acid substitution.

a. **Aminopeptidase N:** The insect's midgut membrane has an important receptor for *Bt* toxins called APN. Sudden heritable change or altered expression of aminopeptidase N provide high degrees of resistance to Cry toxins. For example, APN 1 expression was shown to be lacking in *S. exigua* which is resistant to Cry1Ca. APN1 was not expressed in the resistant strain, according to Northern blot results. Cry1Ac resistance was also identified in the *BtR* strain of *Helicoverpa armigera* with a deletion mutation of HaAPN1 (at amino acids 938–1004).
b. **Alkaline phosphatase:** In resistant insects, the amount of alkaline phosphatase bound to the insect's midgut membrane is considerably lesser than in susceptible ones. According to one hypothesis, the glycosyl on alkaline phosphatase binds the toxins and it allows the toxin to accumulate and speed up the oligomerization of the *Bt* toxin by cadherin, which results in a cell perforation through binding to the ABC transporters. The MAPK signalling pathway is known to cause Cry1Ac resistance by changing the expression of ALP genes. For example, field-derived *S. frugiperda* strains with extremely high Cry1Fa resistance exhibited a three- to four-fold drastic reduction in ALP activity and protein levels.
c. **ATP Binding cassette transporter:** ABC transporters work in tandem with CAD. To create pores, ABC transporter binds to the oligomeric toxins. However, in certain insects, oligomerization is not required. As a result, CAD would be useless in the insecticidal procedure of such insects. To bind and create pores, almost all the *Bt* toxins require a corresponding ABC transporter. For example, Cry2Ab is a receptor for ABCA2, whereas Cry1Ab and Cry1Ac are receptors for ABCC2. ABCC gene expression is altered by the mitogen-activated protein kinase signalling pathway which brings about high Cry1Ac resistance. Furthermore, the loss of amino acids caused by mis-splicing of the ABCC2 gene conferred a high level of resistance to the Cry1Ac toxin. Resistance to Cry1Ab and Cry1Ac is also linked to the downregulation of these genes.
d. **Sodium solute symporter (TcSSS):** Sodium solute symporter is a receptor for *Bt* toxin that increases the number of *Bt*-resistance mechanisms found in insects. It was observed that the gene knockdown of sodium solute symporter protein enhances *T. castaneum's* resistance to Cry3Ba.
e. **Glycolipids:** *Bt* toxin has the ability to bind to glycolipids directly. In a strain of *P. xylostella*, resistance to Cry1Ac is linked to a reduction in glycolipid levels. GSS1 and GSS2 glucosinolate sulfatases have been found to bind directly to Cry1Bd in P. xylostella and play an important role in Cry1Bd toxicity.

4. **Changes in the immune system:** Insects may boost their resistance to *Bt* toxin by increasing their levels of esterases like

carboxylesterase or speeding up the poison's breakdown. Esterase attaches to the active protoxin and prevents it from attaching to the receptor in the resistant population. After feeding on *Bt* toxin, resistant *M. sexta* larvae had higher levels of carboxylic cholinesterase. Insect interactions with *Bt* toxins may potentially be influenced by symbiotic microorganisms. For example, HaDNV-1 (a new densovirus) infected *H. armigera* larvae is more resistant to *Bt* toxin at low dosages. HaDNV is thought to increase *H. armigera*'s resistance to *Bt* cotton and aid the pest's survival in *Bt* cotton-growing regions.

Factors favourable for rapid development of resistance

- Prolonged cultivation of a single gene *Bt* crops.
- High selection pressure
- Large coverage area
- Immigration or migratory
- Short life cycle of insects

Conclusion

The genetic mapping method has shown to be an effective tool in dissecting the intricate genetic basis of *Bt* resistance, and it is likely to remain so in the future but still, further study is required to address resistance in other insects as well as resistance to *Bt* toxins produced from different Cry proteins and families. Clarifying resistance mechanisms can assist and enhance our understanding on modes of action of Cry toxin but more research is needed on resistance mechanisms and resistance development in many instances of field-evolved resistance. Early resistance detection is essential for developing an adaptable and intelligent resistance management approach. Retrospective study of these instances may assist enhance *Bt* resistance management methods by providing a better knowledge of resistance mechanisms to Cry proteins.

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8. GENETICS AND PLANT BREEDING

Biotechnology Dream: Nitrogen-Fixing Cereal Crops

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Introduction

Cereals crops yields about 2000 millon tons annually which includes rice, wheat, maize, sorghum and millets and about two-third population having wheat as their staple diet worldwide. Nitrogen availability often limits cereal crop production. The global population has been estimated to reach 8.6 billion people by 2030 and it is estimated that harvested area has to increase by 185 mha and nitrogen fertilizer production to 132 mt to support agriculture to feed the growing population. The high cost of production, labor intensive nature, use of non-renewable resources

and ill effects on the environment are some factors that make the use of nitrogen fertilizers impractical. Therefore, Biological nitrogen fixation (BNF) is a sustainable option to fulfill the need of nitrogen for cereal crops. In fact, it is found that some bacteria known as diazotrophs contributes by BNF that is about 30–50% of the total nitrogen required by the crop field (Rogers and Oldroyd, 2014).

Biological Nitrogen Fixation is carried out by microorganism through reduction of elemental dinitrogen (N2) into ammonia. These diazotrophic bacteria encodes an enzyme complex known as nitrogenase which catalyzes the reductional process of N2 gas to NH3. Diazotrophs live on the nutrients provided by the plant as malate and in return get fixed N2 in form of NH3, asparagine and glutamine.

Diazotrophs are grouped as PGPR: plant growth-promoting rhizobacteria develops associative or endophytic associations with cereals includes cyanobacteria (found within plant tissues as endophytes, Mus et al., 2016), actinobacteria, bacilli and proteobacteria (alpha-, beta-, and gammaproteobacteria). The group is of root-nodulating bacteria which includes rhizobia and Frankia. Frankia are found to have symbiotic associations with actinorhizal plants while Rhizobia which are alpha- and betaproteobacteria reported to live symbiotically with legumes. A cascade of signaling molecules is necessary for the establishment of this mutualistic relationship. There are different four stages as recognition, penetration, stimulation of host cell division, and differentiation of the endosymbiont for a fully compatible symbiosis

Mechanism of Nitrogen Fixation

Nitrogenase is a complex consisting of the dinitrogenase MoFe protein (component I) a heterotetramer, and the dinitrogenase reductase Fe protein (component II) a homodimer which fixes N2:

$N2 + 16ATP + 8e- + 8H+ \rightarrow 2NH3 + 16ADP + 16Pi + H2$

Nitrogenase is inactivated by oxygen and hence requires microaerophilic environments to function.

Strategies to transfer symbiotic nitrogen fixation to non-leguminous crops

1. Identification and utilization of genes in common symbiosis pathway to establish root nodule symbiosis
2. Inoculation of non-legumes with endophytic diazotrophs
3. Engineering nitrogen fixing plants
4. Use of endophytic bacteria as a chassis for nitrogen fixation
5. Creation of a biased rhizosphere to encourage transkingdom signaling

Nondiazotrophic Cyanobacterium synechocystis sp. PCC 6803 are engineered to have the nitrogenase activity by the 35 nif genes from Cyanobacterium cyanothece sp. ATCC 51142 which is a diazotroph by Liu et al. (2018). Liu et al. (2018) shows the feasible and functional way to improve the nitrogenase activity significantly in low oxygen condition by increasing the nif genes expression level and hydrogenase genes are incorporated to increase the O2 tolerance of nitrogenase and ends up identifying the minimum nif gene cassette need to be incorporation for such activity in Synechocystis 6803 having more than 30% of the N2 fixation activity of Cyanothece 51142 which is highest nitrogen fixing activity achieved in any oxygenic photosynthetic nondiazotroph. Another study by Geddes et al. (2019) for establishing a synthetic signalling networks between bacteria and plants, which can regulate the expression of targeted bacterial gene in the rhizosphere and selection for specific microorganism can also be done which is shown in barley and Medicago truncatula throgh the production of rhizopine scyllo-inosamine expressed by synthetic pathway and its perception by rhizosphere bacteria, containing bioluminescent and fluorescent biosensors. Reprogramming of the nitrogen regulatory framework and genetic regulation of N2 fixation to transform new efficient diazotrophs having association with roots are effective in fixation of N2 as ammonia even in presence of exogenous nitrogen application. Bloch et al. (2020) transformed and remodeled the strain of Kosakonia sacchari, a proteobacteria isolated from roots of maize plant reported to show increased level of N2 fixation in controlled as well as in field conditions in the presence of exogenous nitrogen comparative to the wild strains.

Conclusion and future prospects

The consumption of nitrogenous chemical fertilizers can be reduced by creating the synthetic symbioses or association between crops and diazotrophs. Utilization of diazotrophs isolated from non-legumes in other non-leguminous crops has proved to be a successful method to transfer nitrogen fixation and is simplest method to identify novel associations. The factor which limiting the activity of nitrogenase enzyme is O2 sensitivity and resolved by the engineering nitrogen fixation activity in photosynthetic nondiazotrophic cyanobacteria. The same genes can have different functions in different genotypic and regulatory background so biosynthesis of complete functional nitrogenase is a difficult and promising task but 24 nif gene cluster found to provide sufficient useful framework to resynthesize genes. The transkingdom signalling of Rhizopine is a very promising aspect provides plants to control the root bacteria to create biased rhizosphere and also control the synthetic symbiosis to fix nitrogen. At present status of studies and experimentation one of the feasible method is to decoupled the biosynthesis of nitrogenase and its expression level from the regulatory frame work which respond to the detected level of nitrogen present in the cell which can results in excretion of large amount of N2 even in the presence of external nitrogen, can be the first step to produce transformed strains which can replace or decrease the consumption of artificial fertilizer in cereal crops in near future.

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9. SEED SCIENCE AND TECHNOLOGY

Organic Seed Certification

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Introduction

Organic seed certification is a legally sanctioned label denoting the product have all the organic production standards and issued by a certification body or authority. APEDA, Agricultural and Processed food products Exports Development Authority, developed in the year 2002, regulates organic certification under NPOP (National Programme for Organic Production) standards of the produce, recognized by all European countries and Switzerland. Even though organic seed certification and production were initiated in 2002, established in Tamil Nadu in the year 2007. TNOCD, Tamil Nadu Organic Certification Department regulates and provides certification

based on the NPOP standards under APEDA, New Delhi under the ministry of commerce and industry. TNOCD play a major role in training the volunteers about organic production standards both organic certifications nationally and in Tamil Nadu. They ensure quality seed production and distribution throughout the state.

Due to the increase in the demand for organic produces, organic certification of seeds is getting more important. Organic seeds undergo double certification, by seed certification offer an organic certification and monitoring team. Certification ensures the quality of the seeds, as it provides written assurance of the produce under NPOP standards.

Requirements for Organic Certification

- Avoidance of chemical inputs like fertilizers, pesticides, weedicides etc.... and genetically modified organisms
- Use of farmland under conversion period
- Maintaining buffer zone, the physical barriers between organic and inorganic field
- Continuous inspection of the field

Cultural Practices for Organic Seed Production:

- Land requirement: land should be maintained organically, avoiding contamination by any means by maintaining buffer zones of at least 3 meters distance or live fences. Use of proper sanitized implements and equipment to ensure organic balance.
- Conservation period: The period between organic management and organic certification, a minimum of 3 years required. Helps in the conversion of conventional land into organic land. Have to maintain a proper register of cultivation practices.
- Seeds and planting materials: Either from organic certified sources or the seeds from conventional farming which are untreated. Genetically engineered seeds, transgenic seeds or pollen should not be used.
- Soil conditioning or fertilizing: Use of biodegradable substances which maintains soil fertility and biological activities. Nutrient content of soil can be increased by legumes crops, green manures or any deep-rooted crops. Materials prepared inside the field (farmyard and poultry manure), produced outside the field (Epson salt, clay), microbial preparations (biofertilizers) are permitted for usage.

- Pest management: Removal of disease vectors, or disease vectors. Use of crops and varieties which are resistant to the pest and diseases prevailing in the location. Development and introduction of natural enemies of the pest, non-synthetic control measures like traps, repellents.
- Weed management: This can be done by using mulches, livestock grazing, hand weeding and mechanical cultivation. Improved plastic and synthetic mulches to remove plant weeds.

Organic Seed Certification Procedures in Tamil Nadu

When a producer is producing seeds under NPOP standards and TNCOD standards for organic seed certification, when he/she is willing to allow inspections in all the stages required including all the production and handling operations, areas, offices by an organic seed certification officer and other officials from TNOCD and APEDA. These seeds can be certified as organic seeds.

1. Application for certification: An application should contain details of the producer, reason for application, information relating to the standards maintained. The registration fee, one-time inspection fee, one time travel cost should be paid by the producer with the application form to TNCOD. The standards specified in NPOP should be maintained.
2. Scheduling inspection: The initial inspection is done to inspect the field and the equipment's to be used for the production. Inspections are to be conducted in the presence of the producer. The number of inspections to be followed will be fixed based on the initial inspection and risk factors examined.
3. Granting of certificate: TNCOD issues the certificates like scope certificate, transaction certificate and product certificate to the eligible producers, who followed all the standards of NPOP and TNOCD based on the certification committee.
4. Denial of certification: When there are deviations from TNOCD standards, the producer will be initiated with the reason of denial. When a producer receives a notice of denial of certification, he/she can apply for recertification or go for an appeal to the appeal committee.
5. Recertification: The producer can renew the registration and submit the new report for the production and operations. Producers should submit a new certification with the notification of non-conformities issued by the previous certifier. The report should also contain the preventive measure taken to maintain the TNOCD standards. TNOCD again verifies all the facts and measures.
6. Appeal to the appeal committee: Producers who received the notice of denial of certification can appeal to the appeal committee headed by Director, TNCOD. It should be done in 30 days of notice, and the final certification decision will be taken by the committee.

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10. BIOTECHNOLOGY

Recombinant DNA Technology

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Introduction

Recombinant DNA Technology is technique used in genetic engineering that involves the identification, isolation and insertion of gene of interest into a vector such as a plasmid or bacteriophage to form a recombinant DNA molecule and production of large quantities of that gene fragment or product encoded by that gene. Genetic engineering is not bound by the limitations of traditional plant breeding. Genetic engineering physically removes the DNA from one organism and transfers the gene(s) for one or a few traits into another. Since crossing is not necessary, the 'sexual' barrier between species is overcome. Therefore, traits from any living organism can be transferred into a plant. This method is also more specific in that a single trait can be added to a plant (Khan *et al*., 2016).

How this is achieved? We will be discussing the basic steps involved in rDNA technology, gene cloning or genetic engineering. There are following basis steps of rDNA technology:

Step1: Identification and isolation of gene of interest

Step II: Joining of this gene into a suitable vector (construction of recombinant DNA)

Step III: Introduction of this vector into a suitable organism

Step IV: Selection of transformed recombinant cells with gene of interest

Step V: Multiplication or expression of the gene of interest

Step1: Identification and isolation of gene of interest

DNA extraction is the first step in the genetic engineering process. In order to work with DNA, scientists must extract it from the desired organism. During DNA extraction, the entire DNA from the organism is extracted at once. Scientists use gene cloning to separate the single gene of interest from the rest of the genes extracted and make thousands of copies of it.

The desired DNA is cleaved from the donating chromosome by the action of restriction enzymes, which recognize and cut specific nucleotide segments, leaving a “sticky end” on both ends. The restriction enzymes also splice the receiving chromosome in a complementary location, again leaving “sticky ends” to receive the desired DNA.

The scientists may also get the desired gene from

- Genomic library
- cDNA library
- Chemical synthesis of gene if we know the sequence
- If the number of copies of the desired gene is not enough for gene cloning we can opt for gene amplification techniques like PCR

Step II: Joining of this gene into a suitable vector (construction of recombinant DNA)

For this purpose, a vector is required. A **vector** is any DNA molecule which is capable of multiplying inside the host to which our gene of interest is integrated for cloning. The selection of vector depends upon the size of the fragments to be cloned. Commonly used vectors are plasmids (e.g., pBR 322) and phage vectors.

In the process, restriction enzymes functions as scissors for cutting DNA molecules. Ligase enzyme is the joining enzyme that joins the vector DNA with gene of interest. The resulting DNA is called the recombinant DNA, chimera or recombinant vector (Kumar and Kumar, 2015).

Step III: Introduction of this vector into a suitable organism

Now the recombinant vector is introduced into host cell. This is achieved by different gene transfer methods. Since plants have millions of cells, it would be impossible to insert a copy of the transgene into every cell. Therefore, tissue culture is used to propagate masses of undifferentiated plant cells called callus. These are the cells to which the new transgene will be added.

When the host cell reproduces, the plasmids or vectors inside also reproduce, making multiple clones of their DNA. Because the plasmid DNA contains the desired as well as unwanted DNA clones, the entire product is referred to as a gene

library. The desired gene is similar to one book in that library.

The new gene is inserted into some of the cells using various techniques. Some of the more common methods include the gene gun, agrobacterium, microfibers, microinjection, electroporation, DNA imbibitions by cells, tissues or organs (Transformation) and virus mediated gene transfer (Transduction). The main goal of each of these methods is to transport the new gene(s) and deliver them into the nucleus of a cell without killing it (Lomedico, 1982).

Step IV: Selection of transformed recombinant cells with gene of interest

The number of cells with recombinant vector will be very less. So the next step is to select the transformed recombinant cells with our gene of interest from the sea of non transformed cells. Several methods are employed for selection of transformed cells:

- Antibiotic resistance,
- Visible characters,
- Assay for biological activity,
- Colony hybridization,
- Blotting test.
- The selected cells are cultured in large scale.

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11. AGRICULTURAL SCIENCE

Capsicum: It's Potency in Therapeutic Uses beyond the Taste and Colour

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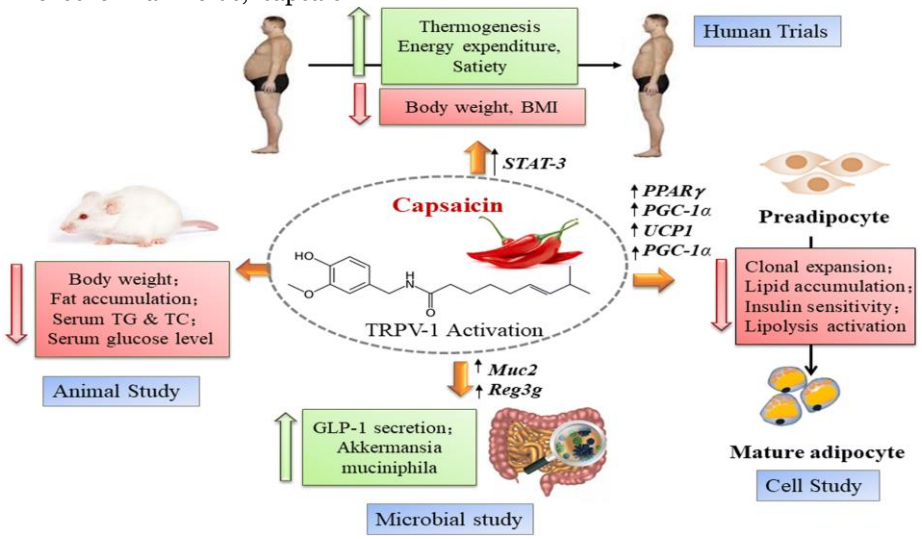
Introduction

India is a country of vast biodiversity and rich in its natural resources. Varieties of spices, herbs, plants, and trees are grown in various parts of the country, which have more than one use. Most of them are rich source of nutrition, some are popular spices, and some have exclusive medicinal uses also. The objective of this article is to give brief and compact information on capsicum and its versatile potential medicinal values, and to consider those for developing some potent and effective drugs with minimum or no side effects for wide range of pathological conditions. Capsicum species has been commonly used as a spice and broadly as medicinal applications. The genus Capsicum contains capsaicin, the pungent irritating compound in the placental area. The concentration of capsaicin molecule differs among and between the species. Capsaicin finds its way in the treatment of various neurological pain syndromes, obesity, nonallergic rhinitis and the associated symptoms in various formulations. Despite the study as an important spice crop, in-depth scientific research for the medicinal benefits is still in infancy stage.

Chemistry all plants from the Capsicum genus produce varied amounts of capsaicin and all of them have been used as a spice ingredient and consumed by humans for over 6000 years. It contains a phenolic compound known as capsaicin (8-methyl-Nvanillyl-6-nonenamide); which is a primary pungent principle and constitutes 80% of capsaicinoid content of chilli peppers that represents an important ingredient

of the majority of spicy foods. Capsicum species are native to the tropical and humid zones of Central and South America and belong to the Solanaceae family, which includes peppers of important economic value. Capsaicin (trans-8-methyl-N-vanillyl-6-nonenamide) is a naturally occurring alkaloid extracted from fruit of the capsicum plant family. It is a member of the vanilloid family of compounds such as vanillin from vanilla, eugenol from bay leaves and cloves, zingerone from ginger and capsaicin from hot peppers. The vanilloids possess a vanillyl (4-hydroxy-3- methoxybenzyl) moiety and this confers their biological activity. Structurally, like other vanilloids, capsaicin has a benzene ring and long hydrophobic carbon tail with a polar amide group.

It is grown widely and consumed as a food additive throughout the world for its pungency compound. Capsaicin is an intriguing molecule since the consumption of chilli peppers evokes opposing sensations (pleasant and unpleasant) depending on the individual experience and chilli pepper consumption habits. Therefore, it is important to understand the mechanisms of capsaicin action in pain modulation as well as in other pathological conditions. If used in the right dosage and frequency, capsaicin promotes pain relief, and so caught the attention of researchers.



Pharmaceutical formulation of capsaicin

1. Topical application The most common therapeutic use of capsaicin is for the management of pain. For the treatment of various pain syndromes, including post-herpetic neuralgia, diabetic neuropathy, and chronic musculoskeletal pain, low-concentration creams, lotions, and patches containing capsaicin (0.025%–0.1% wt/wt) intended for daily topical application have been used. Meanwhile, the high concentration patch containing 8% capsaicin is widely used to treat post-herpetic neuralgia, HIV neuropathy, and other conditions with neuropathic pain symptoms. The application of this formulation does not required medical prescription and is often self-administered.

   The studies have revealed that three to five topical skin applications per day for periods of two to six weeks have modest beneficial effects against various pain syndromes.

2. Oral administration of capsaicin The therapeutic dose of capsule capsaicin has not been established, however, the generally recommended daily dose stated on labels of commercially available capsules is 1350–4000 mg of capsicum with 0.25% capsaicin. Both the lower (0.4–2 mg) and higher (135–150 mg) doses of capsaicin are also effective in accelerating energy expenditure, fat oxidation, thermogenesis, and decrease

appetite in humans. Hence, many findings lead to the role of capsaicin as an effective weight loss and amelioration of obesity. It has been reported that the capsaicin (extracted of Capsicum frutescens Linn.) at the doses of 2.5–10.0 mg/kg may reduce thromboembolism without non-significant alteration in platelets

3. Nasal sprays To treat non-allergic rhinitis and the associated symptoms, capsicum nasal sprays and homeopathic preparation of Capsicum annum and Eucalyptol nasal sprays are used. Although a therapeutic dose has not been established yet, some finding has shown that 4 µg/puff of capsicum, three times a day for three consecutive days, is efficacious for non-allergic, noninfectious perennial rhinitis.

Conclusion

Capsaicin plays an important role in plants health and find its way in the used as spice and condiments. It has been essential to our understanding of physiological and pathological processes of this molecule in improving human health. Though this molecule exists for thousands of years, capsaicin is still an interesting challenge among researchers and presents a wide horizon of potential therapeutic uses. However, for pharmaceutical industry, characterization of capsaicin molecule is needed due to the influence of genetics and environmental on the frequency of this molecule. Though varied pharmaceutical formulations and clinical applications are available, the efficacy of capsaicin is still in infancy stage. Therefore, new pharmaceutical formulations, development of new analogs, or targeting the capsaicin-activated receptor are promising pharmacological approaches in the following years. Thus, we may look forward for wonderful potent drug formulations from Capsicum to enrich, upgrade, and strengthen our pharmaceutical reserves for more than one pathological condition.

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12. HORTICULTURE

Edible Coating: Tomorrow's Packaging Material

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Fresh fruit and vegetable postharvest losses are estimated to be 20–30 percent. Because fruits and vegetables are perishable, cold storage is required to postpone ripening-related changes such as ethylene production, softening, colour changes, respiration rate, acidity changes, and weight loss. However, cold storage alone is insufficient to maintain fruit and vegetable quality during transit and marketing, which frequently results in severe chilling injury symptoms. As a result, proper postharvest technology and cold storage are required.

Synthetic packaging materials are nondegradable, there is an increasing interest in using natural resources to create biodegradable edible coatings. These studies primarily focused on the development of edible coatings and enhancing their qualities in order to apply the major desirable characteristics of conventional synthetic materials, such as high mechanical strength, lightness, softness, water resistance, and transparency. Edible biopolymers such as proteins, polysaccharides, and lipids are one of the alternatives to plastics.

Biopolymers are environmentally friendly, biodegradable molecules that can help to reduce chemical dangers and household waste. Starch, tapioca, corn, cellulose and cellulose derivatives such as HPMC (hydroxyl propyl methyl cellulose), CMC (carboxymethylcellulose), and MC (methylcellulose), quince seed mucilage, Pullulan, alginate, carrageenan, and policaju gum have all been used to make edible films and coatings.

Edible coatings operate as an additional layer that covers the stomata, limiting transpiration and, as a result, weight loss, as seen in a variety of fruits and vegetables such as apple, papaya, carrot, guava, plum, mango, apricot, banana, orange, mushroom, and tomato. Because of its environmentally friendly character, edible coatings are commonly made from animal and vegetable sources and have become a popular method in postharvest processing.

Proteins, polysaccharides, lipids, and a combination of minor components to increase functioning such as plasticizers, emulsifiers, and active compounds such as antimicrobials and antioxidants are the key ingredients of edible coatings. To get the desired effect, a critical quantity of edible coating ingredients must be present. As a result, the composition of edible coatings must adhere to the specific laws of the food product in question.

Effect of Edible Coatings for Preserving Quality and Prolonging the Shelf Life of Fresh/Fresh-Cut Fruits

Pome fruits such as apple and pears are sensitive and suffer from an extremely reduced storage life if not properly care. Coating of the aforementioned fruits using an edible coating has been found to considerably improve the quality and storage life of the fruits. Dhall (2013) reported that China has been using hot-melt paraffin wax as a coating for apples and pears since the 1930's. The paraffin wax, however, is not allowed as an edible coating in many legislations.

In a recent study, Rasouli, Saba, and Ramezanian (2019) found that the synergistic effect of salicylic acid and an aloe vera gel coating can maintain the physicochemical quality and reduce the microbial load of 'Thomson Navel' oranges (*Citrus sinensis L. Osbeck*) for a storage period of up to 80 d at 4 ± 1 °C. The authors reported, treatment of oranges with salicylic acid and an aloe vera gel coating can reduce malondialdehyde and electrolyte leakage, increase the antioxidant activity, and reduce the respiration rate and other senescence process during storage. Reduction in malondialdehyde and electrolyte leakage can minimize the damage of cell membrane by increasing the integrity and semi-permeability, and reducing the activity of the oxidizing enzymes of the cell membrane (Aghdam & Bodbodak, 2013). Furthermore, by maintaining the cellular membrane stability may improve the chilling tolerance of fruits when stored at low temperature.

Drupes are stone fruits that have an outer fleshy component that surrounds a shell with a seed inside. Consumers prefer the fruits because of their organoleptic and nutritional qualities, as well as bioactive components with antioxidant properties. Mangos, cherries, peaches, nectarines, and plums are some of the most popular stone fruits on the market. Stone fruits are easily spoiled once picked, and their quality deteriorates within a short period of time,

ranging from a few days to two weeks, depending on the plant species and cultivar. Low-temperature storage has long been used to delay the postharvest deterioration of stone fruits during handling, transportation, and storage.

The use of edible coatings has been shown to improve the shelf life and preserve the freshness of tropical fruits: Pitaya , soursop, pineapple, papaya ,banana ,longan and guava. All of these tropical fruits have been coated with diverse natural compounds, and their physicochemical properties have changed significantly during storage. In comparison to untreated fresh-cut pitaya, discovered that spray coating fresh-cut pitaya with an apple polyphenol (APP) powder dissolved in hyperpure water resulted in greater colour retention, delayed softening, and lower loss of SSC, TA, betacyanin, and total phenolics. Furthermore, the results showed that APP treatment preserved antioxidant activity and inhibited microbial growth for up to 4 days at 20 °C.

Chitosan have a wide range of potential application in different fields of chemical sciences, biological systems, food sciences, pharmaceutical and medical industries. Chitosan has been proven one of the best edible and biologically safe preservative coatings for different types of foods because of its film-forming properties, antimicrobial actions, lack of toxicity, biodegradability and biochemical properties. It has been proven that the chitosan can control numerous pre and postharvest disease of fresh fruits. Chitosan edible coatings extend the shelf life of the fruits and vegetables by minimizing the rate of respiration and reducing the water loss. Chitosan coating offers a defensive barrier against bacterial contamination and loss of moisture from the surface of food products, thus extending their shelf life. With limited increase in the concentration of chitosan coating, the beneficial effect of chitosan on postharvest life and quality of the food is enhanced. The present review delineates the preparation, properties and potential application of chitosan coatings for enhancing the postharvest life and quality of different types of fruits.

Due to the removal and environmental problems caused by plastic trash, the development of alternative edible biodegradable coatings and films from gums to replace synthetic polymers has accelerated. Several academics have researched and analyzed edible coatings based on gums as viable replacements for synthetic packaging. The usefulness of various gums as an edible covering for delaying ripening and extending the storage life of various fruits and vegetables is suggested in these publications. Natural hydrocolloid-based edible coatings and films provide additional protection for fresh or blanched fruits and vegetables. Natural gum edible coatings are a promising way to improve the taste of food.

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13. SOIL SCIENCE

Bioremediation of Problem Soils through Multipurpose Tree Species

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Multipurpose trees are deliberately grown and managed for more than one output.

They may supply food in the form of fruit, nuts, leaves etc; while at the same time supplying firewood, add nitrogen to the soil, or supply some other combination of multiple outputs. "Multipurpose tree" is a term common to agro-forestry, particularly when speaking of tropical agro-forestry where the tree owner is a subsistence farmer.

Multipurpose trees species should fulfil the following criteria:

- Wider adaptability to local climatic conditions.
- Thin and sparse crown that allows sunlight enter into the system
- Capacity to withstand various management practices like coppicing, lopping and pollarding etc.
- Quick sprouting habit.
- Productive capacity that includes poles, wood, food, fodder, medicinal and other products.
- Good leaf litter making nutrients available at appropriate times in the crop cycle.
- Few and shallow lateral roots (or prunable).
- Ability to assist in nitrogen fixation.
- Resistance to drought, flooding, soil variability and other climatic hazards.
- Deep thrusting taproot system.
- Easy to manage
- Cheap to establish
- Higher demand and better value for the produce.
- Reduce losses from the soil
- Improve soil physical, chemical and biological conditions.

Bioremediation of problem soils

Problematic soils are these soils which are not suitable for arable forming because of specific limitations. In general, problem soils are of two types i.e. physical problem and chemical problems. Agro-forestry systems have the potential tool to make use of marginal and degraded lands through the soil improving effect of trees. It proves to be one of the cheapest and best modes for the reclamation of all problematic soils. Agro-forestry systems like silviculture, silvi-pasture *etc.* can improve the physical and chemical properties of the soil along with additional return on long-term basis.

1. **Bioremediation of physical problems of soils :** For the bioremediation of physical problems of soil like sandy soils, subsoil hardening or hardpan, surface crusting, water logged soils, peat and marshy soils etc. Tree species i.e. *Eucalyptus robusta* (Swamp mahogany), *Syzygium cumunii* (Jamun), *Terminalia arjuna* (arjuna), *Salix tetrasperma* (Indian willow), *Dalbergia latifolia* (Shisham), *Eucalyptus camaeldulensis* (River red gum), *Eucalyptus grandis* (Rose gum) and some grasses like *Bracharia mutica* (Para grass) and *Cynodon dactylon* (Bermuda grass), *Dichanthium caricosum, Brachiaria decumbens* etc. are commonly used.
2. **Bioremediation of chemical problems of soils:** The different chemical problems of soils i.e. salt affected soils (saline, sodic and saline – sodic) etc also reclaimed or managed by the following tree and grass species.

Saline Soils :-

Promising woody species -

- Salvadora persica (mustard tree)
- Prosopis juliflora (mesquite tree)
- Acacia nilotica (Babul)
- Butea monosperma (Palash)
- Terminalia arjuna (Arjuna)
- Salix sp. (Indian willow)
- Dalbergia sissoo (Sissoo)
- Casurina equisetifolia (Saru)

Sodic Soils :-

Prosopis juliflora (mesquite tree) and *Dichanthium annulatum* (Karnal grass) improves the soil conditions to such an extent that after some time or year.

Some fodder species can be grown under trees such as - Berseem (*Trifolium alexandricum*), Senji (*Melilotus parviflora*) and Shaftal (*Trifolium resupinatum*) (Basavaraja *et al*., 2007)

Relative tolerance of fruit trees to sodicity :

Exchangeable Sodium Percentage (ESP) for Sodicity tolerance	Trees

Sensitive : < 20	Mangifera indica (Mango) *Artocarpus heterophyllus* (Jack fruit) *Musa paradisiaca* (Banana)
Low : 20 – 30	*Psidium guajava* (Guava) *Citrus limon* (Lemon) *Vitis vinifera* (Grape)
Medium : 30 – 40	*Punica granatum* (Pomegranate)
High : 40 – 50	*Ziziphus jujube* (Ber) *Tamarindus indica* (Tamarind) *Manilkara zapota* (Sapota)

(Singh et al., 1993)

Saline-Sodic Soils

- Acacia auriculiformis (Akashmoni)
- Azadirachta indica (Neem)
- Casurina equisetifoia (Saru) Dalbergia sissoo (Sissoo)
- Ailanthus excels (tree of heaven)
- Prosopis cineraria (Khejri)
- Acacia tortilis (Israeli babul)
- Acacia nilotica (Babul)

Conclusion

Due to the global efforts in research and development in recent past, the age-old forms of agroforestry are becoming an integrated approach for addressing many of the world's most serious land management challenges. Development of diversified, climate resilient and farmer centric agroforestry systems has tremendous potential to significantly improve the sustainability of agro-ecosystems in problem soils areas bringing tangible socio-economic and environmental benefits to the society and nation.

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14. SOIL SCIENCE

Interaction of Sulphur with Other Nutrients in Soil

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Introduction

Plant nutrient sulphur has assumed considerable practical importance in recent years for increasing crop yield and produce quality. Sulphur deficiencies are widespread and are been reported from more than 70 countries. In the early 1990s, sulphur deficiencies in Indian soils were estimated to occur in about 130 districts. More recently, soil fertility surveys by the ICAR system have shown sulphur deficiencies to be a widespread problem. Sulphur is known to interact with almost all essential macronutrients, secondary nutrients and micronutrients. These interactions can either enhance or reduce growth and yield of crops by influencing the nutrient uptake and utilization. Better understanding of these relationships can lead to more efficient crop production, higher yields, improved crop quality and harvestibility. Future improvements in crop varieties, water utilization, and general improvements of cultural techniques will require a better understanding of nutrient interaction.

Sulphur interaction with nitrogen

An intensive agriculture with use of improved cultivars and high analysis fertilization offers conditions of nutrients exhaustion resulting in nutrient imbalance in soils. It have been reported that lack of S limits the efficiency of added N, therefore S addition becomes necessary to achieve maximum

efficiency of applied nitrogenous fertilizer. Several incubation studies have reported that a high N:S ratio (produced by addition of N) resulted in a decrease in mineralization of S in the soil sample. Researchers have reported the optimum ratio of available N to available S to be 7:1. Ratios below 7 gave the reduced seed yields.

Sulphur interaction with phosphorus

Interrelationship of P and S in soil is manifested mainly in adsorption studies, and formation of reaction products expressed in terms of inorganic fractionation study. Sulphate adsorption is completely stopped by the presence of two-thirds of the equivalent amount of phosphate compared to sulphate. It has been demonstrated that rate of downward movement of adsorbed sulphate and the extent of leaching depend on the quantity of phosphate applied, the presence or absence of plants, and on the type of the plant grown. Pasricha and Sparks (1990) showed that with addition of phosphorus the increased adsorption of phosphate with time resulted in a concurrent desorption of sulphate from the colloidal surfaces. The overall evolution of the adsorption relationships has raised the alarm that a continuous use of large dressings of fertilizer phosphate will aggravate the S deficiency, especially where S is present in critical amounts. The extent of competitiveness between the two anions is related to the genesis of the soil. This appeared to be more serious in weakly to moderately weathered soils from sedimentary parent materials. At the other extreme, soils developed on volcanic parent material and having a high level of native adsorbed sulphate appear to have a capacity to retain added sulphate even in the presence of a similar concentration of phosphate. The influence of S on different inorganic fractions of P is probable due to the similarity in composition of relatively insoluble Al or Fe sulphate and phosphate. The strong affinity of aqueous Al^{3+} and Fe^{3+} for SO_4^{2-} along with OH^- ions, suggests a keen competition among these anions for precipitation reactions with partially neutralized Al and Fe hydrous oxides.

Sulphur interaction with molybdenum

Molybdenum, though required in trace amount, is essential for inorganic nitrogen metabolism as part of nitrate reductase enzyme in most plant species and nitrogenase in legumes. It is the metallic co-factor for nitrate reductase enzyme protein and helps in transfer of electrons from NADH to nitrate for its reduction to nitrite. It seems plausible that under conditions of excessive molybdenum, more than one Mo atoms may attach to the enzyme protein thus making it biologically inactive as a functional enzyme. This results in a decrease in nitrate assimilation and reduced nitrogen; consequently in proteins, nucleic acids, co-factors, chlorophyll, plant growth regulators, and ultimately in growth. Sulphur fertilization generally reduces uptake of Mo. The decrease in molybdenum content with increasing levels of sulphur for plants grown in the soil has been attributed to increased competition for exchange sites at soil-root interface by two bivalent anions of similar charge and size, i.e. sulphate and molybdate Combined application of Sulphur and Molybdenum was more beneficial to produce maximum yield and better quality of crops with fair amount of protein and ascorbic acid. However, the interactive effect of sulphur and molybdenum at higher levels was not statistically significant. This may be attributed to the antagonistic effect existing between sulphur and molybdenum at higher levels as both are absorbed as anions (MoO_4^{2-} and SO_4^{2-}) and probably compete for the absorption site on plant roots.

Sulphur interaction with zinc

Zinc is an important micronutrient, which enters the plant primarily via absorption of Zn^{2+} by roots from soil solution. Interaction of sulphur with zinc has been extensively investigated on yield of many crops. In a Zn and S deficient soil, plants responded to added S only when adequate supply of Zn to soil was maintained. The Zn and S interactions cause increase in seed and dry matter yield and thus, shows synergism. Indications were that S and Zn interaction perhaps occurred both at adsorption sites and within plants. S and Zn contents of plant tissue also correlated well with each other. Some reports, however, show antagonistic relationship between S and Zn (Kumar *et al.*, 1997).

Sulphur interaction with iron

There appears to be a close relationship between Fe and S metabolism in the plant. Application of 10 mg Fe kg^{-1} improved its availability by 10% whereas 80 mg S kg^{-1} enhances it by 49%. The combined application of both the nutrients showed tremendous boost in Fe availability giving the overall improvement of 101 % (Malewar and Ismail, 1997).

Sulphur interactions with selenium

Selenium is considered an essential nutrient for a group of plants called Se accumulators. Other plants which are considered non accumulator, can also absorb high Se concentrations from the soil, if the available Se in soil is high. High Se concentration in plant may be lethal to animals. Se was found to be positively correlated with pH, salinity and $CaCO_3$ in soils. Both synergistic and antagonistic effects have been reported. The antagonism between S and Se is well known. In fact, as the Se content of the fertilizer increases, the S uptake and concentration in the plant decrease.

Conclusion

Sulphur is an important nutrient for plant growth and development. Sulphur interactions with other nutrients are directly related to the alteration of physiological and biochemical responses of crops, and thus required to be studied in depth. This would help to understand nutritional behaviour of sulphur in relation to other nutrients and provide guidelines for inventing balanced fertilizer recommendations in order to optimise yield and quality of crops.

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15. AGRICULTURAL EXTENSION EDUCATION

Socio-Psychological Impact of Covid-19 on Farming Community

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Introduction

India is an agrarian country, where half of the working population is engaged in agriculture and its subsidiary sectors activities for their livelihood, contributing as per 2018, agriculture provides employment to more than 50% of the Indian work force and contributed 17–18% to country's GDP and the share of agriculture in GDP increased to 19.9 per cent in 2020-21. The COVID-19 hit severally to the all sectors including agricultural also. Due to sever spread of pandemic government impose lockdown to reduces the cases on that time farmers faced difficult time to lead the life by timely unavailability of farm inputs, labours, and restriction of the boards to market the farm products. Further, when experiencing income losses, they may resort to negative coping strategies, such as distress sale of assets, predatory loans or child labour. Migrant agricultural workers are particularly vulnerable, because they face risks in their transport, working and living conditions and struggle to access support measures put in place by governments. Guaranteeing the safety and health

of all agri-food workers – from primary producers to those involved in food processing, transport and retail, including street food vendors – as well as better incomes and protection, will be critical to saving lives and protecting public health, people's livelihoods and food security. We must recognize this opportunity to build back better, as noted in the policy brief issued by government. We are committed to pooling our expertise and experience to support countries in their crisis response measures and efforts to achieve the Sustainable Development Goals. We need to develop long-term sustainable strategies to address the challenges facing the health and agri-food sectors. Priority should be given to addressing underlying food security and malnutrition challenges, tackling rural poverty, in particular through more and better jobs in the rural economy, extending social protection to all, facilitating safe migration pathways and promoting the formalization of the informal economy

Socio-Economic Impact of Farmer's Family

- The family members should critically observe and analyze the causes of the depression.
- If a person is found suspicious regarding suicide he should be brought into the social groups and made to mingle with each others.
- The family members should encourage the farmers to express themselves freely there by lowering their stress farmers family may harassment by money lender
- it's difficult to run the family due to unavailability of work
- Timely non availability of farm inputs farmers may face difficult to do the farm operation
- If farmers may died due to covid -19 sometimes children may loose of the other from members from the family
- Children may dropout from the school to work for family needs
- Chance of other family members attempting suicide
- severe food crisis may occur
- Migration of rural people to city
- Farmers may lost its land due to sever health issues

Psychological Impact on Farmer Death Due to Pandemic

- Develop an anxiety and stress which leads to the mental instability
- illness of family members
- Developed senses of hopelessness
- Low self esteem
- Loneliness
- Jealousness
- Prolonged stress

Roles and Responsibilities of Different Stake Holders

Role of Media

- Media should create the awareness about pandemic and health safety measures.
- Media must create awareness about the health insurances and crop insurances.
- The media should publicize those success stories in which the farmers in spite of various physical, mental and financial stresses have succeeded in the farming in an exemplary way.
- Reduction in negative publicity through visual Medias and also reducing the publicity by not publishing on the front page of news paper.

Role of Financial Sectors

The bank should not to force the farmers in the name of recovery of loans should engage in the recovery smooth and pleasing methods.

- Practice of recovery should not harm the self respect of the farmers.
- The loan recovery process should not be done in the public.
- In the process of loan recovery the decent and soft language used and not unparlimentry words.

Role of Government

- Farmers should able to take up direct marketing.
- Farmers should form co-operatives, to shoulder their burden or to face the unseen risks.

- Farmers should be given right price and timely prices (Support price) rather than monetary compassion.
- Farm advisory should be started at block, district and state level.

Socio-Psychological Measures

- Farmers Counseling Centers need to be established in 'Mandal Panchayat'
- Proper training should be given to the Farmers
- Awareness created regarding scientific farming.
- Advise the farmers go for integrated farming system
- Advisory Councils should at District and State level

Conclusion

Due to pandemic may lead to agrarian crisis, which cannot be solved only with firefighting techniques. It needs more time to come back to the normal stage with appreciate short and long term measures, But immediately in short term measures there is an urgent need to declare the remunerative prices for all crops on the basis of cost of cultivation and secondly, in long term measures, the government should focus more on increasing rural infrastructure particularly irrigation facilities, This will definitely help in increasing crop production, productivity, and change in cropping pattern, cropping intensity, and increase in the allied occupations in study area. These things are necessary not only for uphold the farmers socio economically and psychologically.

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16. AGRICULTURAL EXTENSION EDUCATION

Digital Education Advantages and Its Hurdles

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Introduction

Digital Education is a technique or method of learning which involves technology and digital devices. It is a new and wide technical sphere which shall help any student attain knowledge and gain information from any corner across the nation. It is assured that Digital Education in India is the future of education and learning. COVID-19 pandemic had disrupted the education system in India. Since the 1st lockdown in March 2020, all the states have responded to the COVID-19 situation with speed and innovation. The usage of digital media has been increased in education. Digital education means it is way of learning by using digital technology or by instructional practice that makes effective use of digital technology. Digital learning occurs across all learning areas and domains. It gives win-win opportunities for all, at one side School, colleges and institution finds the rapid rise in enrolments and added revenue because of digital education, and on other side students view this as a flexible and alternate option allowing them to study as per their convenient time and pace (Gonda and Gupta .2017). Digital learning involves more participation from students as the current generations of students are well-versed with help of laptops, I-pads, and smart phones. We can find

many government and private players in the area of digital education like e- Pathshala by NCERT, DIKSHA by MHRD and private educational platforms like Tata Class Edge, BYJU'S *etc.*

Advantages of Digital Education

During 2019-20 the in India and the entire world were fighting the COVID-19 pandemic, digital education in India was the sole source of learning for the students in the country.

- This initiative has made students not just gain bookish information but also gain practical and technical knowledge
- No limitation as to the place of learning or studying. With digital learning, a student can engage in online classes or learning anywhere, at any time
- With study material available online, learners can take their time to understand any topic
- Through digital education, learning can be made more attentive and interactive between the learners and teacher
- Digital Education acts as a supplement and does not completely overpower physical education

The Future of Digital Education

- Going forward, the government will focus on getting students industry-ready by evaluating their competencies and helping them get aligned with industry-based skills. To achieve this, the government is promoting Indian institutes and colleges to shift from traditional operations to digital modes.
- The government is also focusing on research and innovation to identify sectors that can further support and strengthen digital education initiatives in India. In July 2021, the government stated that space technology (such as satellite communication) is being used for digital education in India. At present, under the Tele-education Programme, 19 states and A&N Islands have been leveraging satellite communication for beaming educational content in the digital form.
- Indian institutes such as Bhaskaracharya National Institute for Space Applications and Geo-informatics (BISAG-N) is leveraging satellite communication for beaming 51 educational channels.
- Institutes such as the Indian Institute of Remote Sensing is also leveraging digital platforms to train beneficiaries (such as working professionals, UGs/PGs, doctorate students, academicians, school students and school teachers) on space technology and its applications. In 2020-21, these programmes have benefitted ~2.42 lakh members. These initiatives are expected to open the door to more opportunities in space-based applications and digital education.

Hurdles with Digital Education in India

- Internet connectivity to all is one of the biggest requirements for digital education. This will have to be achieved by the Government for easy access to information
- Provision of the devices and technology to the people belonging from socio-economically weaker sections it helps betterment of the people
- Training to teachers is another challenge. It is possible when the teachers are technically sound, they can conduct the digital classes
- Making digital cost-effective should be a key motive of the Government
- To ensure that public schools and colleges are provided with proper facilities for digital classrooms
- Lack of a proper policy on digital education, infrastructure, content, interaction and multiple languages

Conclusion

Rising participation of private players to offer e-learning courses, along with the government's effort to strengthen digital landscape of the country, is expected to boost digital education and consequently, empower students, and also offer opportunities to

emerging technologies. There is no disagreement over the things that digitization of education is the requirement of the hour in order to match the educational environment and system prevailing all over the world. At the same time we must known how this system has to be adopted so as to nullify the adverse impact, of excessive dependence on electronic medium of information sharing, on the young youth and protect them from behavioral and psychological imbalances. It is the need of time that policy makers come up with such system which is a blend of traditional and modernized ways of teaching that is protecting the teacher and learner relationship along with promotion of digital education system.

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17. PLANT PATHOLOGY

Quick Wilt of Pepper – A Major Threat of Wayanad

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Introduction

Black pepper (*Piper nigrum* L.) known as Black Gold is an important spice crop of Kerala. Black pepper is affected by fungi, bacteria, phytoplasma, parasitic nematodes and phanerogamic parasites. Among the various diseases foot rot (quick wilt) disease is the most destructive one prevalent in all the pepper growing areas of Kerala.

Pathogen: Phytophthora capsici

Symptoms

The pathogen infects all parts of black pepper like leaf, stem, spike, collar and root.

- Infection on leaves appear initially as water soaked lesions which expand rapidly into dark brown patches with fimbriate margin and sometimes with a greyish.
- Infection occurs on spike resulting in spike shedding.
- On tender and woody stems, infection occurs as dark wet spots resulting in progressive rotting leading to die-back symptoms.
- Collar and root infections are the most serious and generally the infected vine shows rapid wilting, defoliation and quick death of vine.
- The collar infected vines show yellowing, flaccidity of leaves, defoliation, spike shedding and breaking of stem at the nodal regions.


Symptoms on Leaves


Symptom on Stem


Symptom on Collar Region

Integrated management

An integrated approach are necessary for successful management of the disease.

- Phytosanitation involves, planting disease free cuttings destruction of infected plant materials by burning, treatment of basins with fungicidal drenching, etc.
- Cultural practices involve timely tying or pruning of runner before south west monsoon, mulching the basins to prevent rain splash, prevention of water stagnation and facilitating proper drainage in the plantation. Reduced humidity and presence of sunlight reduces the intensity of leaf infection.
- Establishment of cover crop and minimum tillage to avoid root injury are also found to reduce the incidence of foot rot.
- Application of 1 kg lime and biopesticides like neem oil cake at the rate of 1 kg/vine during May-June will suppress the pathogen.
- In infected fields, spraying of Potassium Phosphonate (Akomin 4ml/l) in 3-4 weeks interval also give control.

- After the receipt of a few monsoon showers (May-June), all the vines are to be drenched at a radius of 45-50 cm with copper oxychloride @ 0.2%. A foliar spray with Bordeaux mixture 1% is also to be given. Drenching and spraying are to be repeated once again during August-September. A third round of drenching may be given during October if the monsoon is prolonged.
- Drenching and spraying pepper vines with talc based *Pseudomonas fluorescens* @ 5 to 10 gram per litre can also control the disease.

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18. HORTICULTURE: MEDICINAL AND AROMATIC CROPS

Abiotic Stress Management in Medicinal and Aromatic Plants

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Introduction

Medicinal and aromatic plants (MAP) are found in vast numbers all over the world. Now a day's people rely mostly upon organic herbal drugs and medicines. Due to climate change, many of the wild MAPs have already been extinct and some are under threat of extinction. MAPs are

- Largely tolerant to drought and floods
- Have low incidence of pest attack
- Have lower cost of cultivation as compared to the traditional crops, since most of them are not high
- input responsive
- Could be raised as inter-crop, mixed crop, companion crop thus can add to diversification and also
- overcome economic loss caused due to adverse climatic conditions
- Can provide better returns at a time as compared to traditional crops in marginal and sub-marginal lands

Plant secondary metabolites are often referred to as compounds that have no fundamental role in the maintenance of life processes such as growth, development and reproduction, but they play a significant role for the plant to interact with its environment for adjustment, adaptation and defence. They are having an impact on the metabolic pathways responsible for the accumulation of other related natural products. The expression level of certain genes governing the production of such compounds has been shown to increase in response to various abiotic stresses.

Drought stress

Drought stress is one of the most significant abiotic stress that affects plant growth and development. There is an increase in secondary metabolites such as saponin, anthocyanin and flavonoids in low water availability conditions. Drought stress cause abnormality in photosynthesis and transpiration that may affect the yield and composition of essential oil (EO). It was suggested that the reduction in leaf area due to water stress might result in a higher density of the leaf oil glands, leading to an elevated amount of oil accumulation.

Salinity stress

Salt environments lead to cellular dehydration, which causes osmotic stress and exosmosis of the cytoplasm resulting in a

reduction of the cytosolic and vacuolar volumes. Salt stress often creates both ionic as well as osmotic stress in plants, resulting in the accumulation or decrease of specific secondary metabolites in plants. Free radical reactions, in Plant stress responses, involve the synthesis of several secondary metabolites of the phenylpropanoid pathway to defend the plant metabolism. Phenolic compounds play an important role in absorbing and neutralizing free radicals, quenching singlet oxygen, or decomposing peroxide radicals.

Temperature stress

High and low temperatures cause drastic changes in physiological and biochemical processes, including water deficit and oxidative stress leading to lipid peroxidation and membrane damage, degradation of chlorophyll and protein, and reduced water status of plants. Elevated temperatures increase leaf senescence and root secondary metabolite (i.e. ginsenoside) and reduce photosynthesis and biomass production concentrations in the herb *Panax quinquefolius*.

Heavy metal

Heavy metals are found naturally in the soils as rare elements and also added to the environment due to heavy traffic, refuse to dump, and metalworking industries. Heavy metal stress is having several undesirable effects on plants leading to plant death and human health hazards. The most abundant heavy metals are lead (Pb), aluminium (Al), cadmium (Cd) etc. The Pb toxicity leads to inhibition of enzyme activities, disturbed mineral nutrition, water imbalance, change in hormonal status, and membrane permeability. In most cases, Pb interacts with free -SH groups that are present in the active site of the enzyme.

Light stress

It is well known that light is a physical factor that can affect metabolite production. A positive correlation between increasing light intensity and levels of phenolics has been reported. UV light is a natural elicitor of secondary metabolite responses. Supplemental exposure to UV-B light has been shown to increase the concentration of secondary metabolites in basil.

Greenhouse gases

From ancient times it has been known that greenhouse gases are responsible for the enhancement of the medicinal value of the plants. It is known fact that initially the CO2 content was too high and during the process of evolution the medicinal plants are the ones whose stability is for a broad range of environments.

Conclusion

Thus it is evident that abiotic stress is increasing the secondary metabolite production in the plants, which is elevating the phytomedicine production and also encouraging the yield of essential oil in aromatic plants. In this era of climate change, this is an opportunity for the farming community to shift the cropping practices from traditional crops towards medicinal and aromatic crops in developing countries like India. The need for time is opening a path for organic and herbal products, which may grant advantage to advances in medical sciences as well as to the overall agricultural production and productivity. understanding of the response of medicinal and aromatic plants to salinity stress by evaluation of the relative tolerance of different medicinal and aromatic plants and their sensitivity at different plant stages; The effect of different environmental conditions - salt-stressed medicinal and aromatic plants; morphological and physiological traits that contribute to salinity tolerance in medicinal and aromatic plants; The ameliorative effects of nutrition and other treatments on growth, mineral uptake, photosynthesis and active constituents of salt-stressed plants; Alleviate the mechanisms of salt resistance in medicinal and aromatic plants.

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19. HORTICULTURE

Bursera: The Fragrance of Forest

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Bursera(Bursera Delpechiana)

Introduction

The Indian lavender is botanicaly named as *Bursera delpechiana* belongs to the family Burseraceae**.** Other names are Mexican Linaloe tree, Tree of Fragrance etc. Economic part is fruit, husk and wood. It contains active principle called linalool.

Bursera is an important essential oil yielding plant. The genus Bursera is named after Joachim Bursera, a famous Dutch botanist. Linaloe berry has some similarity to bergamont mint and Lavender. This tree is known as linaloe and Indian lavender tree and the oil as linaloe oil.

The Uses

In scenting of soaps. It is also used in flavoring food and beverages. The Indian oil is superior in quality compared to the Mexican oil.

About Plant

Bursera is a large deciduous tree. Male tree is medium, has a longer trunk and grows to about 7.5 m. Inflorescence is a paniculate cyme with pubescent axis upto 10 cm long and contains 40-50 staminate flowers. The female tree attains about 6 m height and has larger leaves and some of them are18 cm long. Leaves are pinnate, serrate. Fruit is a fleshy berry, a little larger than a pea, about 1 cm in diameter, dark green in color

turning to a reddish brown as they mature and fall off. The pericarp of the fruit contains resiniferous ducts surrounded by a large layer of thick-walled calls. The inflorescence contains 8-20 pistillate flowers. Flowers are pale green-pale yellow, pentamerous; calyx small, lobes rounded, petals valvate in bud, stamens 10, nearly equal, ovary hairy surrounded by a broad crenate disk.

Origin, Habitat and Distribution

The plant is originally native to Mexico and South America and introduced to India from Mexico in 1920. In India Bursera is grown in Karnataka, Maharashtra and Andhra Pradesh. The area under the crop in India, is around 800 ha, out of which 450 ha, is government owned. The Thatguni estate in Karnataka which is 19 km, away from Bangalore in Karnataka is perhaps the only place in the whole world where linaloe trees were cultivated as full-time regular crop.

Chemical Composition

Linalool (60-70%). The other constituents of the oil are linalyl-acetate, geraniol, -terpeneol, methyl heptenol, linalool monoxide etc.

Species/Varieties

Linalool tree belongs to the tropical American genus '*Bur sera* of the family *Burseraceae* under natural order *Geraniales*. The genus has 45 species. The important species are as follows.

The genus has 45 species. The important species are as follows.

Bursera gumifera - American gum tree' or Indian birch or birds' tree. An infusion of leaves is used as a substitute for tea

Bursera icilarita- Tree bears edible aromatic fruits.

Bursera leptopholes- Mature fruits are edible

Bursera serrate-pulp is edible and also yield essential

Busera simaruba- Commonly called Rumb or `West Indian birch, leaves are used as substitute for tea.

Bursera penicilliata- Every plant part contains essential oil.

Bursera kluggis-Yield triterpenes which have anticancer activity**.**

Soil and Climate

Sandy or loamy soils, Soil pH = Neutral – alkaline, well drained soils are required. It is drought and salt tolerant and also very fast growing in nature. It can be grown Worldwide, tropical dry forests and woodlands, Annual precipitation between (250 and 2,000 mm), frost-free conditions year-round. Annual temperature of 62.6 ˚F (17°C), Evaporation rate that exceeds precipitation i.e., they grown in subtropical.

Methods of Propagation

Natural Regeneration

It is mainly by seeds which are carried by birds, for a short distance. The natural regeneration is also found underneath the tree which is probably due, to fallen fruits. The other means of natural regeneration is by means of coppicing. It coppices well but is not encouraged because of spreading nature of coppices. It rarely produces suckers.

Other Methods

1. **Seeds**

The seed gemination is very low (5-10%). Hence, seeds are sown immediately after collection in the months of February to May. The seeds germinate only during June-July. Nursery raised seedling when they are 15 cm in height have to be picked out and planted into container for few months till they attain an average height of 45 cm.

2. **Vegetative Propagation**
   a. **Air Layering:** This gives 80-100 per cent success. The best season for air layering was found to be October-January. In this case root-initiation was noted in 26 days and the layers were ready for separation in 2 months.
   b. **Cleft-Grafting:** This method of grafting was tried with a view to increase the fruit yield of the species. When male branches are grafted on to a female tree, the pollen produced will certainly facilitate easy pollination. The grafts establish well in 3-4 weeks. About 60-100 per cent success was obtained by this method.
   c. **Cuttings:** Cuttings are the best means of production of new plants, A mother

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plant of above 5 years age is good for selection of cuttings. Cuttings taken in early February and March have proved best. Cuttings of 0.5 to 1.0 m length, 1-3 cm in diameter with clean cut are taken from a well-established mother plant, inverted for 12-24 hours and then planted in polythene bag of 20 cm x 30 cm or earthen pots of 12 cm diameter and 25 cm height filled with sand, FYM and red earth in 1:1:1 ratio. Sprouting takes place in 30-40 days while healthy root system develops in about 4-6 months. The rooted cuttings are maintained in nursery till planting time i.e., August-September.

Planting Method

Pits of 0.5 m cube will be dug at 6 m x 6 m interval and the rooted cuttings will be planted during rains. The pits are refilled with a mixture of FYM, red earth and sand in the ratio of 1:2:3 prior to planting. A pinch of gramaxone is added to the soil to keep off termites. About 300 cuttings can be accomodated in one hectare land. Planting is done in such a way that a male tree will be surrounded by 6-8 female plants to meet the pollination requirements. The plants are staked and watered after planting.

Plant Protection

Pests

Stem borer: Burrows into the young stem and feeds on tissue and dries up the plant. Stem with an exudation and the stem dries up with a dirty film on the surface. The growth of the stem is arrested at this point the growth of the plan tips arrested

Control: No control measures are recommended

White ants: Cause damage to the plant.

Control: Aldrin or Heptachlor may be applied to the soil at the rate of 25 kg/ha.

Diseases

Leaf blight: Burnt appearance on the leaves

Control: Spray coppery fungicides

Downy mildew: Water lesion on down side of the leaves and later they turn dark spots

Control: Spraying of fungicides like Bordeaux mixture at 1%

Dieback: Death of terminal growing point and cracking of stem

Control: Spraying of copper fungicides.

Harvesting Method and Yield

In India linaloe oil is mainly extracted from air dried husks, matured or ripe berries. Whereas in Mexico, it is mostly from heart wood of 50-60 years old trees. The plant bears first crop of fruits during the 3rd or 4th year. Occasionally few fruits set in earlier but it is better to remove them to allow adequate vegetative development in the first instance. They are allowed to bear the crop only after about 5-6 years. The ripe berries have to be handpicked, or ripe fallen fruits have to be collected. On an average the trees come to economical bearing after 10 years of planting

Hand picking – The ripe fruits are individually picked from the trees with the help of ladder and then dried. The only advantage of this method is that it could be followed even in adverse climatic conditions such as during rainy days also.

The disadvantages are:

The husk of fruits requires more time for drying. It is costy, as a number of labourers are engaged and quality of husk with reference to oil content is poor.

Collection of fallen fruits - The ripe and dehusked fruits fall the ground. The ground is kept clean so that dehusked fruits are not lost and thus collected by sweeping the floor of the plantation.

20. AGRICULTURAL SCIENCE

Traditional Medicinal Rice Varieties

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Rice is a major staple food for half of the world's population, providing 50 to 80 % of daily calorie intake. Carbohydrates, proteins, fatty acids and micronutrients (vitamins and trace minerals) are the major nutrient components in rice. Traditional rice genetic resources in India are reported to harbor vast amount of genetic diversity including medicinal properties and aroma. Due to introduction of high yielding, semi-dwarf rice varieties during first green revolution, the traditional varieties with desirable traits were ignored and are now rare in cultivation. Traditional rice varieties have been conserved, developed and used by farmers for over 3000 years. In Tamil Nadu as many as 187 traditional paddy varieties have been revived so far and they are cultivated in vast areas particularly in the Delta region as those who are involved in such cultivation apparently get good returns, compared to conventional paddy growers.

1. **Karuppu Kavuni**

Kavuni- commonly known as Emperor's rice. It enriches the health and ensures the longevity so it is called as purple rice or forbidden rice. It is used to prepare varieties of desserts during ancient times and it is believed that it cures almost all the body related problems. China was the first to use this type of rice. The black color pigmentation is due to the presence of anthocyanin in it, which is normally present in blueberries and blackberries. It has a nutty flavor. Since they are very rich in phytonutrients, consuming it shields you from major risks of heart, intestinal problems, liver problems and much more.

Health benefits

Black rice is highly rich in fiber content and highest level of antioxidants than any other type of rice variety. Consuming black rice on regular basis reduces the risk of asthma preventing cancer and diabetes. It absolutely reduces atherosclerosis – Consuming Black rice helps in removal of fatty materials which gets deposited in the inner walls of arteries. It also prevents the disease which arises due to this. It entirely controls the Hypertension and completely reduces cholesterol. It improves the digestive system and enhances the growth of hair and increases eye sight.

2. **Mappilai Samba**

It is one of most popular varieties of rice, grown in Tamil Nadu. This type of rice is well suited for organic farming. The best part is that, it doesn't require any kinds of manure and fertilizers. It is rich in medicinal value. Typically the rice is red in color. The name Mappillai was given to this type of rice after a famous tradition, where a bridegroom (Mappillai in Tamil) is asked to lift a heavy rock just to express his valiance. In order to gain energy for doing this action, the bridegroom is given the cooked rice to strengthen his energy. Even today, this tradition is being followed in many parts of Tamil Nadu.

Health benefits

Mappillai Samba is rich in Iron and Zinc. It induces the production of Hemoglobin and Myoglobin. Apart from Iron and Zinc, it contains manganese, phosphorus, molybdenum, magnesium. Helps in easy digestion, lowers the heart risks, obesity related problems and helps in a healthy digestive system. It improves the sexual activities. Consuming it helps men to last long in bed. It contains 3 grams of dietary fiber, approximately 48 grams of Carbohydrates and 8% protein in every 50 grams served

3. **Kattu Yanam**

Kattu yanam is one of popular rice in Tamil Nadu. Once seeding process is done, farmers will go for harvest only. It doesn't need manure or fertilizers. Even elephant can hide inside crop cultivated area. Height of plant is that much.

Health benefits

It is rich in calcium, minerals, vitamins, potassium and magnesium. Kattu Yanam is one of the red rice varieties which improves heart health and decreases cholesterol. This rice has a high fiber content which enhances digestion. It is Par-Boiled rice. It is also called as "the enemy of diabetes".

4. **Moongil Arisi**

It is one of most popular varieties of rice, grown in India Forest. This type of rice is well suited for forest farming. The best part is that, it doesn't require any kinds of manure and fertilizers. It is rich in medicinal value. Bamboo rice taste like wheat.

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Health benefits

It is considered to be a healthier option for diabetics, due to its low glycemic index. It also strengthens and energies the body. Rich in Vitamin B6, calcium, potassium and phosphorus content. It reduces and relieves joint pains and diseases such as rheumatoid arthritis. It lowers cholesterol levels. Slightly sweet in taste and generally cooked like any other rice. Soak this rice for at least 12 hours before cooking.

5. **Kichili Samba**

The name Kichili was derived because of its natural fragrance like citrus fruit. It is always known by the name GEB 24 or Kichadi Samba. It is the mother DNA to all the popular IR varieties of rice. It is 135 – 140 days crop and shows a steady growth up to 3 feet. The rice is small in size and it is cultivated organically. This type of crop requires less fertilizer and mostly grown in Kancheepuram, Sirkazhi and Thiruvannamalai, Tamil Nadu. There are a few variants in this type of rice. But some of them are prominent, which are Ahttur Kichili Samba, Arcot Kichili Samba and Ottu kichili Samba. This type of rice has a unique flavor which improves the taste of curries and sambar when consumed together.

Health benefits

It is easily digestible. Consuming this type of rice is highly suitable for diabetes patients, since it has relatively low glycaemic index value of 50. It helps in Strengthening of body and muscles. Makes skin look glossy. It boosts the immune system and keeps us away from various diseases.

6. **Thuyamalli**

As the name indicates in Tamil, Thuyamalli is Thuya (Pure) + Malli (Jasmine), pure jasmine. The reason why pure Jasmine was given to this type of rice is just because of its resemblance of the bud of Jasmine flower. Further this rice type doesn't require much pesticide. It is one of the indigenous rice varieties of Tamil Nadu. It is a pear colored and it is milled rice. Now is the trend is eating polished rice like Ponni. Having said that, there are people, who are still following our ancestor's footsteps and consuming our traditional rice varieties. But, only certain types of food create the fondness, when tasted it once. Thuyamalli rice is one among them. It is seen to be grown in Kalapaganur village of Salem district. There's a quote in Tamil "Unave Marunthu" which means "Food is Medicine" – Tamil ancestors were living a healthy life by in taking nutritious foods. Now is the golden time for us to return back to our healthy eating life style.

Health benefits

It not only strengthens the Nervous system, but keeps the entire nerves in the body to be active. It prevents diabetics completely. It is pretty simple to cook and helps is easy digestion. Helps the skin to be free from wrinkling and keeps it hale and healthy. Eating this rice, helps us to be active both physically and mentally. One of the best benefits is, it prevents the internal organs from quick ageing.

7. **Seeraga Samba**

Having Tamil Nadu as native, Seeraga Samba (Seera) is the most expensive rice grown. It has ovular grain and has a distinct taste with starch flavor. The grain is much harder than the other types. On the contrary, it looks less fluffy and loose when cooked.

Health benefits

It helps in fighting cancer – Since this type of rice has selenium in it, consuming it prevents the occurrence of colon and intestinal cancer. It has higher Calorific value. It is highly rich in fiber and anti-oxidants. This helps to eradicate free radicals from the intestinal tract and colon. It acts as a shield to the heart and this type of rice has ample amount of phytonutrients in it, consuming it helps women to be free from breast cancer. It is easy to digest and helps to get rid of constipation.

Traditional Rive Varities	**Duration**	**Recipes**
Karuppu Kavuni Arisi / Black Kavuni Rice	175-190 days	Idly, Dosa, Puttu, Plain rice for Meals and Black rice Risotto
Mappillai Samba / Bridegroom rice	155-160days	Dosa, Pancakes, Plain rice, Idly,Upma and Pongal
Kattu yanam	125-130days	Dosai, Kanchi and Idly

Bamboo Rice / Mungil arisi	years	Dosa, Plain rice, Idly, Kichidi and Payasam
Kichili Samba / Attur Kichili Samba	140 days	Plain rice, Briyani, Sweet kozhukattai (Steam rice dumplings)and Suitable for preparing tiffin
Thuyamalli	130-140 days	Briyani, Idly – Idlies made using this rice are really gorgeous. Dosa, Plain rice, Lemon rice, Tomato rice and Tiffin items
Seeraga Samba / Jeera Samba	140 – 160 days	Plain rice, Briyani

Conclusion

Traditional rice varieties are known to be rich in dietary fibre, resistant starch, minerals, carotenoids, flavanoids and polyphenols and consumption of grains of these pigmented rice varieties help in improving human health. Apart from this, these traditional paddy varieties have strong characteristics that help them survive climate change impacts such as droughts, heavy rains, and floods, compared to newer varieties used in chemical intensive paddy cultivation. The traditional rice cultivation was environmentally friendly, thus successfully grew in natural conditions.

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21. HORTICULTURE/POMOLOGY

Precision Farming Practices in Banana

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Banana- Banana (*Musa paradisica* L.) belongs to the family Musaceae and genus *Musa,* a plant genus of extraordinary socio-economic significance to mankind. The name banana comes from the Arabic word 'BANANA', which means finger. It is also known by other synonyms like 'Adam's fig,' 'Kalpataru,' 'Tree of wisdom' and 'Apple of Paradise.' It is one of the oldest fruit crop known to mankind. Banana is the leading fruit crop in tropical and subtropical regions of the world. It ranked second after mango in area and production and grown in more than 132 countries of the world. The fruit is recognized as the fourth most important global food commodity in terms of gross value exceeded only by paddy, wheat and maize. It is the staple food of many countries and can be utilized for fodder and fiber too.

Precision Farming

Precision Farming is generally defined as an information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource.

Precision farming practices

Development of improved varieties

The main objective of varietal improvement in banana is to develop varieties resistant to biotic and abiotic stress, resistant to major pest and diseases and diseases and are able to produce good yield with good shelf life. Cavendish banana are the most promising banana types and from the Cavendish group various clonal selections had been made. Major varieties under varieties under cultivation in south India include Grand Naine,

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Ney poovan, Nendran, Rasthali, Basrai, Shrimanti, Ardhapuri, Robusta.

Improved Propagation Techniques

Micropropagation- In banana, the difficulty in obtaining a large number of uniform disease free plants with high yield potential by the conventional propagation technique is one of the major limiting factors for increasing productivity. Another important problem faced by the growers is the staggered flowering. Tissue culture technology enabling the rapid production of a large quantity of uniform, disease free planting materials from a single plant showing good genetic potential is gaining importance in recent days. The advantages of tissue culture banana plants are true to the type of mother plant. No room for variations in a well-managed plant production, better establishment in the field due to accelerated growth and well developed root system for better absorption of nutrients, infection free planting material, uniform growth of plants unlike plants cultivated using suckers and thus minimum number of harvests that reduces the cost and increases the scope for getting a uniform ratoon crop.

Macropropagation-Tissue culture banana plants have many advantages over conventional suckers however it is not possible to meet the demand of planting materials and the plants are costly. Hence, a simple, farmers friendly method for mass multiplication has been developed to meet the supply of healthy planting material. This method generates plantlets from sword suckers as initial explants and farmers can adopt especially to enhance the planting material production and conservation of traditional cultivars right in their back yards. The main principle of this method is production of more suckers by encouraging lateral buds can be accomplished by suppressing the apical dominance and by providing suitable environment in terms of substrate and exogenous hormones. This technology can use whole suckers, large pieces of parent corms or sword suckers to produce planting material.

Modification in planting system

In traditional method the banana was planted at a didtemce of 2.7*2.7m but now days high density planting systems have been developed . For the Cavendish group cultivars like Basrai, Shrimanti, Grand Naine high density square planting at 1.5 m x 1.5 m is recommended. It accommodates 4,444 plants/ha. In this system, even though there is a severe competition for sunlight however in high density planting it has many advantages like it helps to cover the all the canopy area and prevents the radiations to reach the soil. It creates the microclimate in the garden by way of reduction in the soil temperature, weed growth and evaporation losses from the soil and increase in relative humidity. It also protects the plant and bunches from hot scorching sun during the summer months. Pair row system of planting at 0.9 X 1.5 X 2.1 m is also recommended in Maharashtra. It also accommodate the 4444 plants/ha. Farmers from western Maharashtra are also adopting 1.5 X 1.8 m, 1.8 X 1.8 m or 1.8 X 2.1 m spacing.

Nutrient management

- **Use of organic sources and Bio-fertilizers:** Nutrient Management By nature banana is a heavy consumer of nutrients for its optimal growth and production, consuming 20-30 per cent of the cost involved in productionUse of biofertilizers has been considering the soil health and sustainable production. Most commonly used Biofertilizers are Azospirillum and phosporus solublising bacteria (PSB) 25 g each per plant at the time of planting is recommended for increasing production along with organic sources i.e. 10 Kg FYM or 5 Kg vermicompost at the time of planting.
- **Fertigation:** Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid fertilizer as well as water soluble fertilizers are used. By this method, fertilizer use efficiency is increased from 80 to 90 per cent. Fertigation schedule in banana has been standardized but iy varies with the cultivar and region.

Water management:

Banana is a succulent plant requires high amount of water ranging from 1,800- 2,500 mm water annually. In traditionally method farmers are applying irrigation at an interval of 4 – 7 days as per the season and crop growth by the traditional method of flow irrigation .Now a days, majority of banana growers are using drip irrigation system which is an innovative method of irrigation by providing precise and measured quantities of water directly to the root zone. Principle involves supply of water drop by drop through plastic emitters or drippers through a low pressure delivery system.

Bunch Management practices

Bunch management practices like Denavelling, bunch feeding, bunch spraying, bunch covering have been practiced to get high yield with good quality bunches. Banana Research Station, Jalgaon has recommended the two sprays of Potassium di hydrogen phosphate (0.5 %) + Urea (1%) on banana bunch at 5 and 20 days after last hand opening which helps in improving the overall quality of bunch, enhancing maturity and yield of banana. The bunches are then covered with perforated (2 to 6% vent), 100 gauge polyethylene bags which protects the bunch from thrips, beetles, dust, rains and from low temperature during winter, scorching sun in summer and enhances the maturity with increased yields.

Intercropping: Intercropping is a common practice in banana orchards to check the weed growth and to increase the soil fertility and augment the income. In the initial stage, in interspaces different short durational intercrops can be grown.

Mulching : Mulching has major implication for conserving soil moisture with benefits like suppression of weeds and regulation of plant micro climate.Use of Polythene mulches is common practice in banana cultivation now a days. Apart from polythene mulches use of organic mulches like sugarcane trash, paddy straw and dried banana leaves and sheaths are cost effective apart from addition of organic manure to the soil.

22. AGRICULTURE

Bioplastics from Agricultural Wastes

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Use of plastics is widespread worldwide because of their versatility and their excellent process ability, thermal and mechanical properties. Most prominent cause of plastic pollution is the single-use plastic/disposable plastic (plastic carry bags, straws, cups, cutlery, water packets, cling wraps, bottles). About 380 million tonnes of plastic is produced and discarded every year throughout the world. Major part of this discard is accumulated in the environment with only 10–13% recycled. Despite their ubiquitous usage, they are non-biodegradable because of stable carbon–hydrogen bond and very large complex polymeric structure, thus remaining for longer periods of time in the environment causing ocean and land pollution. They usually disintegrate into tiny fragments over long periods of time, which are ingested by smaller eukaryotes, which in turn by higher eukaryotes, affecting the entire food chain, and many species are in endangered situation because of this. Each year, an estimated 8 million tonnes of discarded plastic enters through coastal region into world's ocean. These plastics cause serious threat to coral reefs that are suffocated in plastic bags; turtles, whales and sea birds with plastic stuffed in their bellies and nostrils clogged with straws leading to painful deaths.

Burning of plastics leads to emission of massive amount of carbon dioxide into the environment causing air pollution. They also release toxic chemicals causing hazards to life and environment as a whole. Production of biodegradable alternatives with greater safety and compatibility with the environment is necessary. Bio-based plastics are made from renewable sources like corn, potatoes, wheat and vegetable oil through chemical or biological

process which include hydrolysis, acidification, microbial fermentation, etc.

Starch based Plastics

In general, starch-based plastics are more cost competitive than alternative bioplastics. They can accommodate a wide range of physical properties that alternative bioplastics lack, such as tensile strength and heat tolerance. Starch composites can also incorporate recycled plastics. Starch can be used to reduce the carbon footprint of traditional resins because they can replace petroleum-based polymers with natural ones. It is also highly degradable, meaning it can be used alongside a compostable polymer without interfering with the degradation process. Starch-based plastics have increased in relevance with the introduction of improved resin grades, their ability to blend with other biopolymers and an increasing number of suppliers. In fact, starch-based bioplastics are widely employed in the medical industry because of their biocompatibility, low toxicity, degradation properties and mechanical properties.

Cellulose Based Plastics

Cellulose plastics are bioplastics manufactured using cellulose or derivatives of cellulose. Cellulose plastics are manufactured using softwood trees as the basic raw material. Barks of the tree are separated and can be used as an energy source in the production. The properties and chemical composition of cellulose esters is dependent on the acids and anhydrides used in the production process. Major applications for cellulose plastics include thermoplastics, extruded films, eyeglass frames, electronics, sheets, rods, etc. Molding materials is the most dominant application segment for cellulose plastics and the trend is expected to continue for a foreseeable future. Plastic is produced mainly using non renewable sources such as crude oil and its several derivatives owing to which, the carbon footprint is high during the production of plastics. Moreover, other issues such as biodegradability and other environmental hazards associated with traditional plastics have led to surge in number of regulations to control the use of plastics. The regulations imposed on plastics have led to surge demand for bio based plastics and thus has been driving demand for cellulose plastics. Furthermore, increasing demand for electronics products such as transparent dialers, screen shields, etc. has been among foremost growth drivers for cellulose plastics market. Softwood is the dominant raw material used in the production of cellulose plastics and increasing number of deforestation regulations is a major restraint for the market. Easy availability and low cost of conventional plastics is also among major restraint for cellulose plastics market growth. Moreover, high efficiency and comparative cost benefit of conventional plastics over cellulose plastics has restrained market growth for cellulose plastics.

Protein-Based Plastics

Corn and soy-based protein plastics are being developed as an alternative to petroleum-based plastics. They are biorenewable, biodegradable, and naturally release fertilizers during degradation. These plastics can be molded into any shape and used with existing equipment. Mechanical properties are similar to petroleum-based plastics. Possible applications include home and garden supplies, toys, building materials, and industrial packaging. Wheat gluten is among the proteins that forms the most cohesive material. Therefore, it has been used to improve the cohesion of other protein materials. Wheat gluten plastics can be made into many different types of products, including flexible films, foams and rigid solid 3D items. It can be coloured in all kinds of colours and made opaque or translucent. Proteins plastics are stiff and to obtain flexible products, these have to be plasticised with e.g. a natural sugar (keeping the whole product bio based). There are many possible applications for protein-based plastics and even though they are moisture sensitive, for more demanding environments (high moist conditions), they can be prepared with antimicrobial agents (in the same way as wood is for certain applications).

Biodegradation of Bioplastics

Bioplastics are able to biodegrade in different environments hence they are more acceptable than conventional plastics. Biodegradability of bioplastics occurs under various environmental conditions including soil, aquatic environments and compost. Both the structure and composition

of biopolymer or bio-composite have an effect on the biodegradation process, hence changing the composition and structure might increase biodegradability. Soil and compost as environment conditions are more efficient in biodegradation due to their high microbial diversity. Composting not only biodegrades bioplastics efficiently but it also significantly reduces the emission of greenhouse gases. Biodegradability of bioplastics in compost environments can be upgraded by adding more soluble sugar and increasing temperature. Soil environments on the other hand have high diversity of microorganisms making it easier for biodegradation of bioplastics to occur. However, bioplastics in soil environments need higher temperatures and a longer time to biodegrade. Some bioplastics biodegrade more efficiently in water bodies and marine systems; however, this causes danger to marine ecosystems and freshwater. Hence it is accurate to conclude that biodegradation of bioplastics in water bodies which leads to the death of aquatic organisms and unhealthy water can be noted as one of the negative environmental impacts of bioplastics.

Bioplastics, currently accounting for less than half of one per cent of all plastics manufacture, are growing rapidly because of the clear advantages they have in many applications. As oil supply tightens, these advantages will grow. Their carbon footprint can be much lower than oil-based equivalents. Bioplastics can provide excellent biodegradability, helping the world deal with the increasing problems of litter, particularly in the world's rivers and seas. Durable plant-based bioplastics can also be recycled as well as their conventional equivalents, assisting the growth of a more sustainable world economy.

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23. FOOD PROCESSING

Astaxanthin: Powerhouse of Antioxidant

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Astaxanthin - naturally occurring red carotenoid pigment classified as a xanthophyll, found in microalgae (*Haematococcus pluvialis*) and seafood such as salmon, trout and shrimp most powerful antioxidant ability. It is a red fat-soluble pigment astaxanthin has more potent biological activity than other carotenoids. Due to its structure, astaxanthin is a promising factor in the prevention of diseases associated with oxidative stress, including diseases of the vascular and cardiac system, diabetes and cancers. The construction of astaxanthin enables it to combine biological membranes and to reduce and stabilize free radicals. **(Mularczyk *et al.*,2020)**

Fan *et al.*, 2017 investigated a protective effects and mechanism of ATX against Homocysteine-induced cardiotoxicity in H9c2 rat. Results revealed that Astaxanthin (ATX) pre-treatment blocked Homocysteine (Hcy)-induced mitochondrial dysfunction by regulating Bcl-2 family expression. Moreover, ATX effectively attenuated Hcy-induced oxidative damage via scavenging intracellular reactive oxygen species (ROS). Hcy-induced cardiotoxicity in vivo was also significantly inhibited by ATX through inhibition of oxidative damage and apoptosis, and improvement of the angiogenesis. Overall ATX suppressed Hcy-induced cardiotoxicity in vitro and in vivo by inhibiting mitochondrial dysfunction and oxidative damage

To determine the mechanism of anticancer effects of astaxanthin in gastric carcinoma cell lines by **Kim *et al.* (2015).** Result revealed that

viability of each cancer cell line was suppressed by astaxanthin in a dose-dependent manner with significantly decreased proliferation in KATO-III and SNU-1 cells. Astaxanthin increased the number of cells in the G0/G1 phase but reduced the proportion of S phase KATO-III and SNU-1 cells. Phosphorylated extracellular signal-regulated kinase (ERK) was decreased with astaxanthin concentration, and the expression of p27 increased the KATO-III and SNU-1 cell lines in an astaxanthin dose-dependent manner.

Hussein 2015 determined the cardioprotective activity of astaxanthin against Isoproterenol-induced cardiotoxicity in adult rats. Oral administration of astaxanthin at a concentration of 50 and 100 mg/kg body weight daily for 58 days showed a significant protection against-induced alteration in plasma and cardiac superoxide dismutase (SOD), Glutathione peroxidase (GPx), Reduced glutathione (GSH) and catalase (CAT) as well as Creatine phosphokinase-MB (CK-MB), Lactate dehydrogenase (LDH), Alanine aminotransaminase (ALT) and Aspartate transaminase (AST) activities. In addition, astaxanthin reduced plasma CK-MB, LDH, ALT and AST as well as cardiac Malondialdehyde (MDA) and Hydroperoxide (HP) levels as compare to control group. Astaxanthin renders resiliency against isoproterenol cardiotoxicity due to its antioxidant and free radical scavenging activity.

To examine the protective effect of astaxanthin extracted from the shell waste of deep-water pink shrimp (*Parapenaeus longirostris*) against oxidative stress of alloxanic adult male rats **Sila *et al.* (2015**). Results showed that Alloxan treatment revealed a significant elevation in plasma glycemia and lipid parameters such as total lipid, total cholesterol and triglycerides compared to the control group. The activities of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione reductase (GR) and reduced glutathione (GSH) levels decreased significantly compared to control group. Moreover, diabetic rats presented a significant increase in the activities of aspartate transaminase (AST) alanine transaminase (ALT) and alkaline phosphatase (ALP) in plasma, indicating considerable hepatocellular injury. Astaxanthin treatment restores these parameters near to control values.

Li *et al.*, 2015 to determine the protective effect of astaxanthin (ASX), an antioxidant, on hepatic Ischemia Refusion (IR) injury via the reactive oxygen species/mitogen-activated protein kinase (ROS/MAPK) pathway. Results revealed that ASX reduced the release of ROS and cytokines leading to inhibition of apoptosis and autophagy via down-regulation of the activated phosphorylation of related proteins in the MAPK family, such as P38 MAPK, c-jun N-terminal kinase (JNK) and Reduced (ERK) in hepatic IR injury.

Palozza *et al.*, 2011 determine the growth-inhibitory effects of the astaxanthin-rich *Haematococcus pluvialis* were studied in HCT 116 colon cancer cells. Results revealed that *H. pluvialis* extract (5–25 μg/ml) inhibited cell growth in a dose- and time-dependent manner, by arresting cell cycle progression and promoting apoptosis. At 25 μg/ml of *H. pluvialis* extract, increases p53, p21 and p27 expression with a decrease of cyclin D1 expression and protein kinase B (AKT) phosphorylation. And same concentration of *H. pluvialis*, strongly up-regulated apoptosis by modifying the ratio of Bax/Bcl-2 and Bcl-XL. Growth-inhibitory effects by *H. pluvialis* were also observed in HT-29, LS-174, WiDr, SW-480 cells.

Among the carotenoids (xanthophylls), astaxanthin has recently received increased scientific interest due to its potent antioxidant activity. Naturally occurring red carotenoid pigment found in microalgae *(Haematococcus pluvialis)* and seafood such as salmon, trout, and shrimp. Ability of astaxanthin to attack active oxygen species is about 10-fold higher than that of zeaxanthin, lutein, tunaxanthin, canthaxanthin, β-carotene and 100-fold higher than that of α-tocopherol. Due to its unique molecular structure that is responsible for its powerful antioxidant activities by quenching singlet oxygen and scavenging free radicals. Due to its strong antioxidant property, anti-inflammatory, anti-apoptotic, and immune modulation, astaxanthin has gained growing interest as a multi-target pharmacological agent

against various diseases.

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24. SOIL SCIENCE

Soil Piping

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Introduction

Soil erosion is not only a geomorphologic, but also a land degradation process that may cause environmental damage affecting people's lives. This process is caused both by overland and subsurface flow of water. Over the last decades, most studies on soil erosion by water have focused on surface process, such as sheet, rill and gully erosion, although subsurface erosion by soil piping has been reported to be a significant and wide spread process. Dispersive nature of soils and seepage were found to be the main reason for piping to occur. Various identification methods are developed for distinguishing dispersive soils with ordinary erosion resistant clays. Soil piping erosion or tunnel erosion is one of the factors which lead to formation of land subsidence. It is defined as the hydraulic removal of subsurface soil, causing the formation of underground channels and cavities. The evidences shows that piping performs as a function of drainage and erosion but the drastic collapse of roof of the soil strata makes it one of the silent triggers. Piping has been observed in both natural and anthropogenic landscapes, in a wide range of geomorphologic, climatological and pedological settings. This is not a Universal process but it is important to certain localities. Soil piping has been reported in almost all climatic zones of the world, i.e. from arid and semi-arid through tropical, temperate conditions.

Piping Erosion Process

Soil piping is a unique phenomenon. It was first described by Downes (1946, 1949). Piping erosion has been observed on a variety of soil types, ranging from duplex, loess and uniform clayey soils. It occurred on many climates with wide variation in temperature, rainfall and seasonality of rainfall. Both Impermeable and highly permeable soils containing highly expansive montmorillonite and kaolinite clays are

discovered to undergone piping failures. Studies shows that piping results from a complex interaction of physical, chemical processes associated with dispersion of clay, mechanical scouring and mass wasting (slope movement).

The field erosion may be initiated by a range of process including loss or disturbance of vegetation which results to the development of cracks and generation of subsurface runoff, formation of gully erosion which provides the water to flow outlet, poor consolidation and disturbance of dispersive clays or increased infiltration due to ponding. Piping erosion initiates from the dispersion of sodic clays in low electrolyte water. Two particles of clay with a high concentration of adsorbed sodium ions when sit close to one another, the double electron layers of these ions overlap or interact. Thus a difference in osmotic pressure is developed between the clay platelets and the soil solution which draws water between the particles, causing them to hydrate and swell. If the water is of low electrolyte nature then the clay platelets swell to the point that clay platelets detach from each other, this process known as spontaneous dispersion. Rainfall and excess run off after the initiation of the piping erosion entrain more dispersed clay particles, resulting in both head ward and tail ward expansion of cavities until a continuous pipe is formed. And at the final stage piping may reach to an extent where complete roof collapse occurs and erosion gullies form.

Forms Of Piping

According to study conducted by NCESS (Sankar et.al, 2014) there are mainly 4 types of soil pipes can be observed in field. These kinds of pipes which depend upon geomorphology, soil type, hydrogeology, etc. The classification is done on the basis of the diameter of each pipe. The four types of soil pipes are as follows:

Micro Pipes (Juvenile Pipe):- Micro pipes or juvenile pipe are the initial stages of piping. The diameter of pipe is ranges from < 5cm. Clayey and lateritic soils are favorable for the formation of juvenile pipes. Juvenile pipes are commonly found in the besides of railway track.

Small Pipes (Younger Pipes):- Small pipes are the second stages of development of the soil pipe. The diameter of pipe is ranges from > 5cm to 30 cm. It may combine together or individually developed as the formation of small pipe.

Typical Pipes (Mature Pipes):- Mature pipe is the third stage of development of pipe. The diameter of pipe ranges from 30 cm to 5 m. It may have an outlet; it acts as an underground drainage.

Oversized Pipes (Huge Pipes):- It is next stage of pipe after development of a typical pipe. The diameter of huge pipe is >5m. It may have an outlet. It acts as an underground drainage, it has no definite shape.

Conditions For Occurrence Of Piping

Soil piping is not an instant or as sudden process; it takes years depending on the area and type of soil present over there. Rosewell (1970) identified two preconditions that required for the formation of piping erosion (1) the soil must disperse into the water that moves through the soil and (2) the soil must have sufficient permeability in either the soil matrix or macro pores to enable the movement of dispersed clay particles without blockage. The physical properties which favors for the cause of piping are slope, elevation, and rate of flow of underground water, structure, texture, porosity, and permeability of erodible material, chemical properties of soil like, clay mineralogy, pH, sodic soils, and electrical conductivity of soils. No single factor or group of factors is universally responsible for the development of piping, but the initiating factors vary in different situations.

The importance of both physical and chemical soil properties in soil piping has been discussed by several authors. The importance of both physical and chemical soil properties in soil piping has been discussed by several authors, expressed by high values of SAR and ESP. Also, the presence of swelling clays enhances pipe development. Some double layer clay minerals (e.g. smectite) with sodium present on the exchange complex swell and disperse upon wetting, rendering them very erodible. However, it seems that chemical soil properties are more important in arid and semi-arid environments, especially in badlands. Further more, in temperate regions the geochemistry of the soil is assumed to be less relevant to pipe initiation. Physical soil properties that control soil

erodibility, and thus soil piping are texture, structure, consistency, porosity, and bulk density. Soil piping has been reported in almost every soil texture, even in sands and loamy sands Na^+ characterized by high pH, significant content and high biological activity. It is most often reported in fine- and medium-grained textures, especially in silt-rich soils, which mainly develop in loess sediment.

Land Subsidence By Piping Erosion

Land subsidence is a gradual is a gradual settling or sudden sinking of Earth's surface due to movement of earth materials. In highlands of Kerala during monsoon season land subsidence has become a very common phenomenon which is a threat to human life in all aspects. Land subsidence occurs naturally and artificially. In order to produce surface subsidence, the erosion mechanism is believed to require three conditions (Aalen, 1969): (1) an impermeable stratum at the top of pervious easily erodible material to form as a roof for the tunnel formed, (2) water must have access to the erodible material with sufficient head to transport grains of silts or sand and (3) proper outlets available for the disposal of flowing water and carrying sediments.

In the Western Ghats, it usually occurs in the lateritic terrains. Land subsidence due to soil piping was first reported in Thirumeni village, Kannur district, where a large ground subsidence occurred in 2005. A detailed field inspection by CESS (now NCESS) indicated that this subsided area is connected with large underground tunnels. In the beginning it was thought that this was an isolated incidence. But subsequently several such incidences were noticed in different part of the highlands. Investigations Carried out by NCESS have indicated that the areas adjoining Kannur/ Kasaragod districts in the Coorg locality of Karnataka are the most infested zones with soil piping. Apart from Kannur and Kasaragod other districts such as Kozhikode, Wayanad, Palakkad, Ernakulam, Kottayam, Idukki, Pathanamthitta are also reported to be prone to soil piping.

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25. FOOD SCIENCE AND NUTRITION

Tomato Pomace as a Source of Nutraceuticals - An Overview

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Introduction

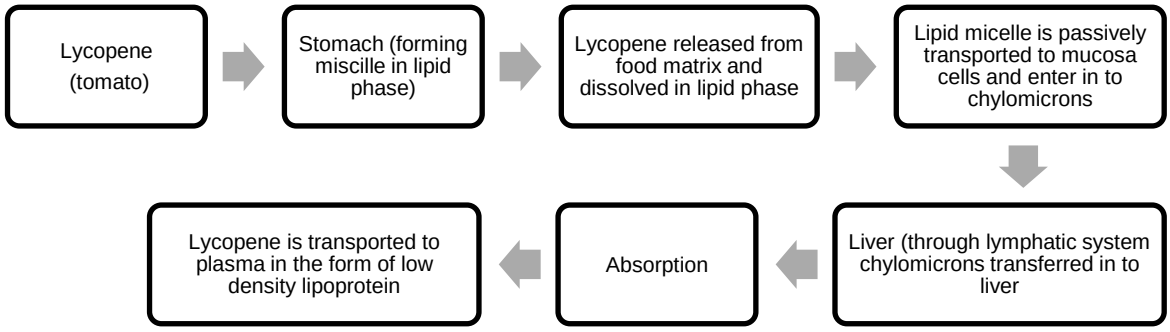
One of the major drawbacks of food manufacturing industries was food waste which contains high value components like polysaccharides, flavor compounds, proteins, phytochemicals which acts as functional ingredient in both pharmacologically and nutritionally. To minimize the cost of waste disposal several techniques for recovery were successfully applied in terms of tomato

processing. Lycopene is a fat soluble compound (carotenoids) present in different foods for giving color with a molecular structure of $C_{40}H_{56}$. Important source of lycopene was tomatoes available at cheap cost and it has a huge demand in the market due to its carotenoids content. The pigment which contains conjugate double bond is responsible for absorbing light during process of photosynthesis. The factor which effects the lycopene content present in tomatoes are the water content of 50-75%. High amount of lycopene content was in cherry tomatoes. The cis-isomer of lycopene was absorbed in greater amount compare to tans-lycopene because of solubility in bile acids for making it bioavailable. Lycopene is an unsaturated acyclic carotenoid with 11 linear conjugated and two non-conjugated double bonds, its not a precursor of vitamin A. These are the important physico-chemical properties which are mostly seen when used in application of nutraceuticals.

Extraction of lycopene from food:

The beneficial biological effects of lycopene it is used as nutraceuticals, functional food and supplements. Instead of usual extraction techniques new technologies were developed for improving the recovery rate from tomato peel. The extraction process of lycopene content may increase the bioavailability in human body. By using thermal processing also we can go for extraction of lycopene but it is done by controlled process it affects the sensory properties and health benefits of final products. The extraction methods of lycopene were broadly divided in to 2 types like green techniques and organic solvent extraction. The green house technique was used due to organic solvents are toxic to environment, the toxic traces in the final product may make the product unfit for consumption. In the organic solvent extraction the commonly used methods were soxhlet extraction, microwave assisted extraction, solvent extraction, enzyme assisted extraction, high hydrostatic pressure assisted extraction and ultrasound-assisted extraction and in green house technique most commonly used one is supercritical fluid extraction. After extraction, concentration process is carried out to create more stable extract in terms of physical, chemical and microbial characteristics. The concentration process eliminates the solvent from the sample, lowering its humidity and extending its shelf life while lowering transportation expenses. Hot air, spray dryer, rotating evaporator, lyophilization and far-infrared radiation are the most prevalent procedures for concentrations. The main disadvantage of some methods, such as hot-air and spray-drying because it causes degradation such color darkening, nutritional value loss, flavor changes. The rotating evaporator, lyophilization and far-infrared radiation are the best options. The concentration methods are also use to prepare the sample for identification analysis. Before making the product available on the market, identification analysis determines if they obtained extract meets the quality requirement using lycopene measurement and purity determination. The most common method was high-performance liquid chromatography which was found in 76% of the retrieved items. Nuclear magnetic resonance came in second with 9%, followed by ultraviolet-visible and infrared spectroscopy both with 7%. The authors observed remaining 1% in other spectrophotometric techniques. With increased interest in the nutraceuticals advantages of these potential carotenoids, both food extraction and chemical synthesis have shown symptoms of slowing. More study has been done in this area in order to find other pathways, such as metabolic engineering.

Ingestion and absorption:



Therapeutic uses of lycopene

Tomatoes and tomato-based products are good providers of a number of phytochemicals that may have health advantages. Tomatoes are high in vitamin C, vitamin A, potassium and folate, among other nutrients. Lycopene was found to be the most powerful antioxidant. Carotenoids in mixtures were more efficient than single substances. When lycopene or lutein was present, the synergistic effect was strongest. Lycopene acts as a scavenger of singlet oxygen ($1O_2$) and peroxyl radicals (LOO•) in the body. In energy transfer reactions, lycopene's highly conjugated double bonds play the most crucial role. Diabetics have a high level of free radicals, which can cause difficulties, however antioxidants like lycopene can help to minimize complications and function as an anti-diabetic. Lycopene has inherent ability to reduce free radicals which is beneficial in several diseased conditions in old age. The impairment in memory in old age can be minimized by regular use of lycopene containing product. The treatment of lycopene using 3-nitropropionic acid-induced rats has significantly improved the memory and restored glutathione system functioning. Increased plasma lycopene levels have been linked to a lower risk of cardiovascular disease and breast cancer.

Nano carriers are being used to improve lycopene solubility, stability, and bioavailability

Although lycopene has numerous biological properties, its use presents some challenges due to characteristics such as high lipophilicity, insolubility in aqueous solvents, and stability and degradation issues. Solutions, such as its association with nanotechnology, are being sought to avoid these difficulties. Nanotechnology has been extensively researched as a means of increasing lycopene accessibility, bioavailability, and absorption because it can protect the molecule, improve properties such as solubility and bioavailability, and avoid toxicity issues. By use of nanoparticles it was came to know that there was low degradation of lycopene.

Anti-Oxidant Activity of Tomato Waste:

Tremendous reactivity of lycopene long polyene chain with free radicals, lycopene is an excellent antioxidant, allowing singlet oxygen to be eliminated and reactive oxygen species to be reduced (ROS). Reduced ROS accumulation and oxidative stress, inhibition of inflammatory pathways (TNF-, IL-6, and IL-1), NF-kB and apoptotic (caspase and Bbl-2), and activation of the nuclear factor E2-related factor 2 (NFE2L2)-antioxidant response element (ARE), increasing antioxidant enzymes levels like superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (bMECs). There was an increase in heme oxidase (HO-1) mRNA expression in cardiac myo-fibroblast cells (H9c2), which was likewise induced by oxidative injury. Lycopene lowered levels of kinases over expressed in oxidative stress (p-ERK1/2, p-JNK, and p-p38), stress proteins (hsp70 and hsp90), and an indication of ROS-induced DNA damage in THP-1 cells exposed to H2O2 (8-OHdG). IKK activation/ phosphorylation, IkB implicated in NF-kB inactivation, and NADPH oxidase-4 expression linked to ROS generation were also

suppressed. Other antioxidant mechanisms involving the NFE2L2 pathway include a decrease in interferon-gamma and IL-10 levels in C57BL/6 mice lungs after cigarette smoke exposure, and a reduction in malondialdehyde (MDA), myelo peroxidase (MPO), and caspase-3 in lungs and kidney tissues in Sprague-Dawley rats with thermal trauma (oxidative injury).

Utilization of tomato pomace waste as by-products

The principal component of the peel portion of tomato pomace is cutin, which is non-toxic, biodegradable, and water-proof. Tomato pomace is also a source of natural pectin (8 percent wt. on dry basis), a thickening agent utilized in the food sector, according to researchers. Due to its health-beneficial features, researchers studied the tomato peel composition and established its potential usage as a source of carotenoids, natural colors. Tomato pomace is the leftover cuticle (or peel), seeds, and small amounts of pulp from the processing of tomatoes. It's frequently used in animal feed as a source of dietary fibre, B vitamins, lycopene, and, to a lesser extent, vitamin A.

Conclusion

Many researchers have found that consuming lycopene-rich foods can help avoid degenerative illnesses in humans. Lycopene's interaction with other active chemicals is critical to its optimal function in human health. In the gastrointestinal tract, the isomer cis is more soluble, making it easier to absorb. On the other hand, this isn't a naturally occurring isomer; instead, it's usually the consequence of an isomerization. External variables, primarily high temperatures, trigger isomerization processes, which can degrade the final product, impacting not just its sensory quality but also its health advantages. Solvent extraction and supercritical fluid extraction were found to be the most popular extraction procedures in recent years. Centrifugation and evaporation, primarily using a vacuum rotary evaporator, were the most often utilized concentration methods. The most popular analytical procedures used by researchers were HPLC and UV–vis spectrophotometer. Another aspect to consider is that lycopene's insolubility in aqueous solvents, stability, and degradation make it difficult to employ as a nutraceuticals. Nonetheless, due to the lack of conclusive results on the role of lycopene in human health, more research into clinical aspects of lycopene, its mechanism of action in diseases, bioavailability, bioaccessibility, recommended intake, interaction with other compounds, and metabolites activities is required.

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