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Potential application of Pomegranate Peel as a natural food additive

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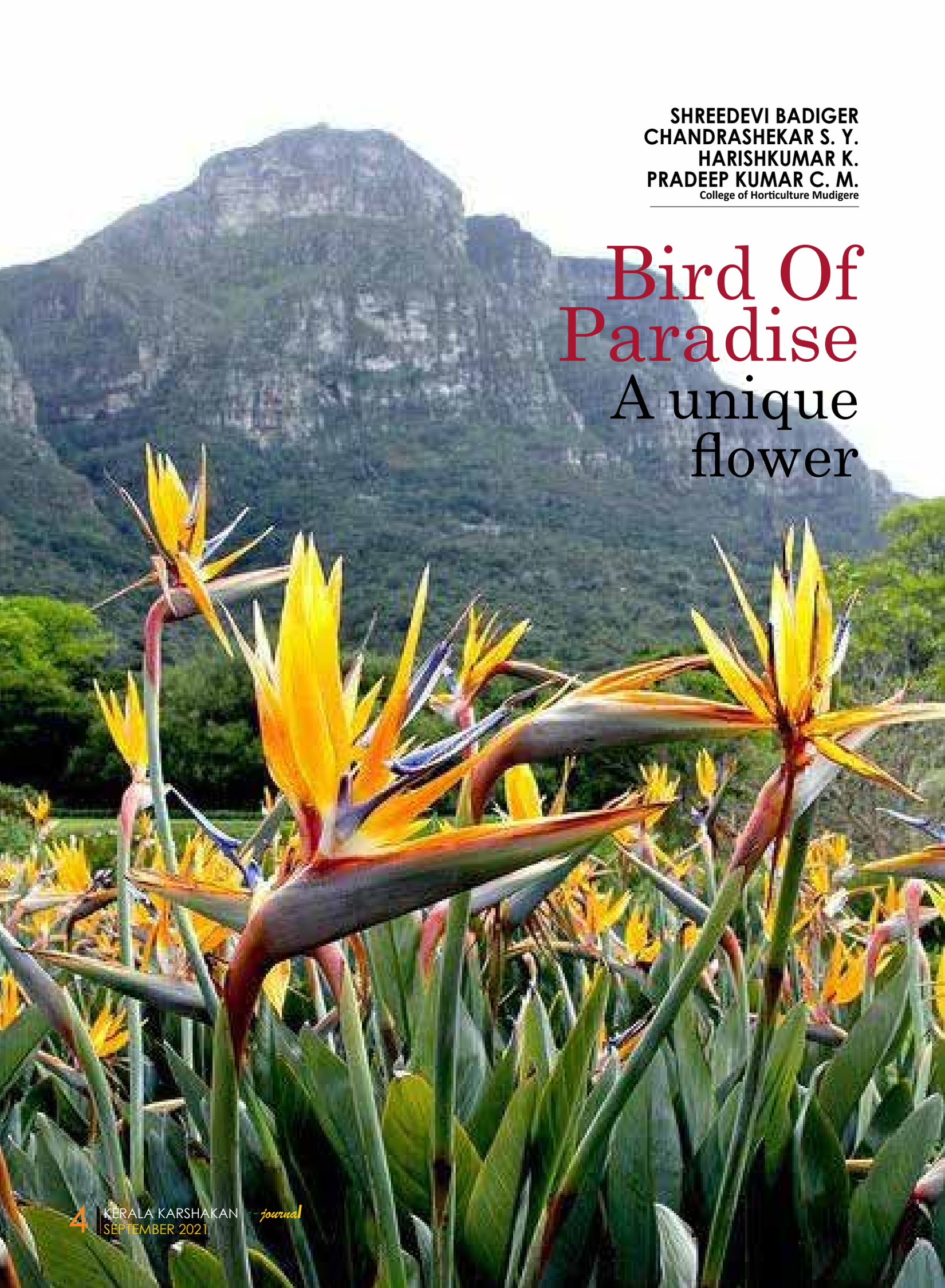
Bird Of Paradise
A unique flower



INTRODUCTION:

Bird of Paradise is known as *Sterlitzia*, It belongs to genus *Sterlitzia*. It is an evergreen perennial herbaceous plant and grown in the regions having a moderate subtropical climate. It is called bird of paradise due to the unique and exotic shape of flower along with brilliant colours like orange, yellow and blue, resembling head of bird. It is exceptionally popular as a cut flower and because of its unique appearance it is also called as crane flower. Commercial production of cut flower is done in California, Hawaii, Israel, France, South Africa, Japan etc. In temperate countries like Netherlands, Poland, China, Japan, etc. this plant is being grown in greenhouses with heating facilities.

In India, Bird of Paradise is grown in sub-temperate and sub-tropical regions like Himachal Pradesh, Kalimpong and Darjeeling in West Bengal, Nilgirihills, Western Ghats, Bangalore and adjoining areas in Karnataka etc.

Bird of paradise occupies a place of pride in the garden and is an important choice for landscaping. It can be used for planting in island beds surrounded by annuals and ground cover. It is grown in backyard and also for mass effect to enhance the beauty of garden; bird of paradise can be used in the landscape as a low growing ground cover.

BOTANICAL DESCRIPTION:

Scientific Name: *Sterlitzia spp.*
Family: *Sterlitziaceae*
Order: *Zingiberales*
Sub-class: *Zingiberidae*
Chromosome No: 2n=14,22

PLANT MORPHOLOGY:

Plants are rhizomatous, with erect woody stem and form clumps of long stalked leaves, upto 90cm long. The evergreen, long petioled bluish or grey-green, leaves are oblong and possess a leathery texture.

SPECIES:

Strelitziareginae: It grows up to 90cm in height. Flowers are having brilliant colours like orange and purple emerging from the purplish spathes on stem.

It consists of 3 varieties, viz.,

Humilis: Having compact growth habit.

Glauca: Glaucous leaved.

Rutilans: Brilliant colour with purple midrib in leaves.

Strelitzia augusta: Plant grows upto 5m high and leaves are 60-90cm long, oblong acute. Petioles are 120-180cm long. Inflorescence consists of 2 spathes shaped like birds head from the middle of which emerge the white flowers on short purple pedicels.

Strelitzia kewensis: It is a garden hybrid developed by crossing between *Strelitzia augusta* and *Strelitzia reginea*. Plant grows upto 1.5m in height and leaves resembles *Strelitzia augusta* and flower resembles *Strelitzia reginae* with pale watery yellow colour and grows vertically. At the base of the sepals is a small noded petal, more like the other parent having lilac pink patches.

Strelitzia alba: It is commonly known as white bird of paradise. Plant is larger tree. Similar to orange bird of paradise, grows up to 5.5 to 6.0 m. Flowers are larger than the normal bird of paradise. It is up to 25 to 30cm long having white with light blue tongue and sits in a purplish bract. Mainly grown as a ornamental plant.

Strelitzia nicholea: It is commonly known as giant bird of paradise, grows to a height of 10m when mature. Leaves are 3m in length, flower buds are bluish white with blue tongues and reddish-brown bracts about 30-45cm long. Plant grows best at 10-24^{0}C. They can grow in temperature as low as 5^{0}C but only for short period of time.

Other species includes like *Strelitzia candida, Strelitzia juncea and Strelitzia parviflora*

ORIGIN AND DISTRIBUTION:

Bird of paradise is native to South Africa. The name comes from remarkably shaped and coloured flower cluster, like the crested head of a bird. It was introduced to European gardens in 1773 through the shipment of horticultural specimens bound for Royal Botanical Garden of King George III. *Strelitzia reginae* was named after the king's wife queen (reginae in Latin) Charlotte of Mecklenburg-Strelitz *(Strelitzia)*.

Yellow colour *Strelitzia* is known for a number of years. Initially at Kirstenbosch in 1970, there were seven yellow plants in the nursery. John Winter started to increase the plants and it took twenty years of careful selection to release the variety Kirstenbosh Gold in 1996. Later it was renamed in the honour of Nelson Mendela as Mendelas Gold.

Bird of paradise

is commercially grown in California, Hawaii, Israel and South Africa for production of cut flowers. Strelitzia occupies a place of pride in several gardens all over the world. In India it is grown as a garden plant as well as for cut flower production.

CLIMATE

Bird of paradise starts flowering after 3-4 years of planting; it can be grown in open or semi-shaded condition. The more the plants are exposed to sun light, the greater the blooming. Low light intensity may cause flower abortion; while as too much exposure to sunlight on summer may cause scorching of leaves.

A temperature of 10-13°C at night and 20-22°C during the day is ideal for early and uniform flowering; while a temperature higher than 27°C tend to promote leaf production and inhibit flowering. But at the same time if temperature goes below 13^{0}C, it results in slow rate of leaf growth and flower production.

SOIL

Strelitzia prefers well drained loamy soil with a pH of 7.5 and rich in organic matter. It has got high drought tolerance but poor soil salt tolerance. In cool climate, however, they can be grown in greenhouse either in borders or in pots having loam based composts. Media should consist of one part each of organic, soil, peat and sand.

PROPAGATION

Strelitzia is commonly propagated by seeds, division of clumps and separation of offsets.

Seeds: Fresh seed should be sown in spring or early summer for best result. Soaking of seed in ethrel solution at 2000 ppm for 48 hours after removing aril of seed improved germination up to 80%. A constant temperature of 25^{0}C is most suitable for germination and low temperature retards germination. It produces a mature plant in about three years under ideal condition.

Offsets: The offset usually take 3-5 years to come into flowering. However, with proper planning and correct fertilizer management early flowering can be obtained.

Division: It is the easiest method of propagation. In early spring before the new growth has started, the plant should be removed from the container or soil. With sharp knife cut the rhizome to separate them, each cut stem should have at least 4-5 shoots. The cuts are dusted with a rooting hormone and planted in a sterile medium. Watering should not be done for 2-3 days to give the cuts a chance to grow callus and thereafter irrigation is done.

LAND PREPARATION

The land should be ploughed thoroughly and harrowed 2-3 times. The entire

weed should be removed and FYM should be incorporated during early ploughing.

MANURES AND FERTILIZERS

Strelitzia reginae is an easy plant to grow and it thrive in most soils. For healthy plant growth phosphorus rich fertilizer is needed. Fertilizers should be applied monthly during the flowering season. Well-rotten farmyard manure at the rate of 4-5 kg/m^2 and fertilizer containing NPK with the proportion of 3:1:5 encourages flowering and can be alternated with other formulation. Foliar application of 6g super phosphate and 3g potassium nitrate per litre of water at an interval of 10 days is very effective for a period of three months and later interval can be increased to monthly once.

SPECIAL CULTURAL OPERATION

For commercial *Strelitzia* cultivation, Pits of 60 x 60 x 60 cm are made and filled with soil, sand and farmyard manure at the ratio of 1: 1: 1. Planting may be done at a spacing of 60 x 60 cm with a planting density of 4plants/m^2. Planting should be done either during early spring or at the beginning of monsoon.

Plants produce tall flower stalks. To keep the flower stalks erect, the plants should be provided with the proper supporting system. Two or three rows of strings along the rows of plants supported by iron poles will be sufficient to support the plants.

IRRIGATION

During summer months, watering should be done twice a week to keep the soil moist and, in the winter, irrigation once in 7-10 days will be sufficient. Due to rhizomatous nature and fleshy roots, the plants cannot withstand waterlogging. High soil moisture is however desirable during the flowering season.

Weed control: Weeds can be controlled through mulching. Mulching around the plants with a 7-8 cm layer of well composted organic mulch conserves moisture, reduces weed infestation and provide micronutrients.

The herbicides like Surflan, Devrinol can be applied successfully to remove the weed from strelitzia field.

INSECT PEST

Scale(Aspidiotes camolliae):It is an important pest and can be controlled by treatment with insecticidal soap or removed by hand with a sponge and soapy water. Spraying with malathion or sevin (0.2%) also effectively control scales.

Mealy bug (Planococcus citri and Pseudococcus longispinus): Infection can be controlled by spraying malathion (0.2%).

NAMATODES

Nematodes cause problem in the roots of Strelitzia. Use clean potting mixture or soil while repotting and topdressing every year. Pots should be kept off the ground to prevent nematodes in the native soil from infecting the potting media.

FUNGAL DESEASES

Root rot (Fusariumm onoliforme): The plant is prone to this pathogen at seedling stage. The rotting starts when there is high humidity. This is controlled by combination of ethazole + thiophanat-methyl or pre-soaking of seed in water at room temperature followed by hot water treatment at 30^{0}C for 30 minutes.

HARVESTING

Bird of paradise flowers is generally harvested for local markets when the first floret has just opened. For the distant markets, the flowers are harvested when they show orange-yellow colouration but have not yet emerged from the sheath as the open florets are very likely to break during transportation.

The flower stalk is harvested near the ground early in the morning while still turgid. After harvesting the stems are kept in the bucket full of water.

POST HARVEST MANAGEMENT

The cut stems of flowers are trimmed to 60-80 cm length. Stem length has a significant role in postharvest life; the longer stems have a greater postharvest life. Pulsing tight flowers in the solution of 10 % sucrose + 250 ppm 8-HQC + 150 ppm citric acid for 48 hours at 22^{0}C can improve its storage period greatly. The vase life is 10-15 days. The fresh leaves are used in floral arrangement for creating a green background in display. The dry leaves creates a wonderful rhythm in floral arrangement.

YIELD: It starts flowering 3 years after planting. After that it produces around 1-3 spikes per plant.

PACKAGING AND STORAGE

The flower stem of bird of paradise are wrapped separately using butter paper or polyethylene sheet and stems are packed in 120×50×30cm cardboard box and stored at 8°C temperature.

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Digital Device for **Diagnosing Red Palm Weevil** Infested Coconut Palms

Red palm weevil *[Rhynchophorus ferrugineus(Olivier)]* is one of the devastating insect pests invading coconut palms. Being a fatal enemy, complete loss of the palm is realized in a period of two months of infestation and therefore an economic threshold of 1% is recommended. Young palms aged between 5-15 years old are highly susceptible and

Weevil infested palms

the dwarf genotypes are more preferred than tall varieties. The pest incidence is more prevalent in Central and South Kerala, where a debilitating malady, root (wilt) disease is predominant. Entire biology and life stages of the pest are observed within the palm system after the mobile adult females (ferruginous snout weevil) lay eggs on the injured parts of palm. Any injury on palms including lightning damage and diseases such as leaf rot and bud rot predisposes the pest attack. Upon eclosion, the apodous grubs feed within the palm system and rotten the feeding tissues enabling easy absorption. In this feeding process, choking of crown fronds, yellowing of leaves, oozing out of brown viscous fluid, presence of immature pest stages including fibrous cocoon and bore holes are quite explicit. Feeding grubs do produce a gnawing sound which could be heard by placing our ear along the trunk of the infested palm. Despite such visible and audible symptoms, many a times farmers diagnose the pest attack at later stage of infestation and before they could initiate any curative measures, the crown of the palm get collapsed leading to the death of the palm.

Detector

In this context of early diagnosis of pest infestation by red palm weevil, ICAR-Central

Red palm weevil detector

Plantation Crops Research Institute initiated a public-private partnership programme with the Start-up firm M/s Resnova Technologies, Kochi to evolve a digital device for timely detection of pest infestation so that curative measures could be undertaken at the appropriate time. This programme was funded by Coconut Development Board, Kochi. After a period of two years of intensive Research & Development, a hardware prototype comprising a sensor, processing unit, display system and power pack as energy source was developed.

Red palm weevils

Weevil infested palms

The sensor is placed on the palm trunk about 1m from ground level and the scan button is pressed for recording the signals. The embedded hardware captures and observes lower order acoustic signals. The device employs hardware and software filtrations to remove unwanted noise signals. Then the Artificial Intelligence (AI) models assess the processed signals for signs of any grub activity.

Red palm weevil detector

The AI models checks for patterns pertaining to the gnawing sound produced by the feeding grubs. In a time frame of two minutes, the display panel will indicate the presence of grubs as detected or absent. Based on the outcome displayed on the panel,

curative measures if any needed could be initiated. This is one of the very few products where cutting edge technologies like Artificial Intelligence and signal processing is being successfully employed for pest diagnosis to help the farmers.

The field efficacy in pest detection was found to be as high as 80% which is fairly a good percentage. Based on the field validation outcome, it has to be converted into a marketable product so that farmer's could procure and use. The marketable product would cost about Rs 10000/-.This is an indigenously developed product and would stand as a successful innovation in our growth towards a self-reliant India.

The product would also have demand in the Middle East as well, where date palms are severely infested by the pest in their region.

Potential application of Pome Granate Peel as a natural food additive

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Food additives are the ingredients used in a small quantity in the processing and storage of food to extent shelf life by oxidative and microbial stability, improve colour, flavor, appearance, beside this it also add nutritional benefits. In addition to this, food additives also play a role in keeping the freshness and appeal of food till it reaches to consumer table. The overall acceptability of food products with respect to consistency, palatability and wholesomeness is also maintained due to addition of food additives (Pandey and Upadhyay, 2012). Food additives can be natural or synthetic. Commonly used food additives in food industry are synthetic as these are cheap and can be stored for longer duration but it is reported that the consumption of foods with synthetic food additives over longer period of time may cause health hazards and side effects such as nausea, cancer, allergic reaction, obesity, heart disease etc. However, natural additives are safe to consume as these comes from plant source. Nowadays because of more concern about diet and health, people are looking for food with natural ingredients which are safe to consume for long time. The co-products of fruits and vegetable processing industry are rich source of bioactive compounds. The potential of fruit waste may be utilized as natural additives in food as alternative to synthetic.

The peel of pomegranate *(Punica granatum L.)* comprised of about 50% of fruit weight is usually discarded as waste from processing industries and create environmental pollution (Nair et al., 2018). The pomegranate peel is rich in bioactive compounds especially tannis (ellagitannins such as punicalin and Punicalagin), phenolic compounds, flavonoids which are responsible for anti-microbial activity, antioxidant activity and antimicrobial activity. Detailed chemical composition of pomegranate peel powder is shown in Table 1. The pictorial presentation for preparation of pomegranate peel powder is shown in Figure 1.

The phytochemical compounds of pomegranate

Table 1. Chemical composition of pomegranate peel

Sr.No	Components	Content
1.	Dry matter (DM) %w/w	30.57 ± 0.25
2.	Ash (inorganic matter) %w/w	5.49 ± 0.33
3.	Ether extract (EE)(crude fat) %w/w	2.4 ± 0.15
4.	Crude protein(CP) % w/w	3.95 ± 0.06
5.	Crude fiber (CF) % w/w	12.61 ± 0.23
6.	Neutral detergent fiber (NDF) % w/w	17.83 ± 0.15
7.	Acid Detergent fiber (ADF) %w/w	14.55 ± 0.07
8.	Total polyphenol content (mg/gm)	40.53 ± 0.26
9.	Vitamin A (µg/gm)	14.06 ± 0.08
10.	Sodium (mg/kg)	763.66 ± 0.73
11.	Potassium (mg/kg)	16237.41 ± 0.96
12.	Calcium (mg/kg)	645.70 ± 0.88
13.	Magnesium (mg/kg)	1644.47 ± 0.86
14.	Phosphorus (mg/kg)	33.96 ± 0.75
15.	Iron (µg/g)	22.6 ± 0.75
16.	Copper (µg/g)	6.2 ± 0.4
17.	Zinc (µg/g)	8.03 ± 0.67

(Source: Kushwaha et al., 2013)

peel extract can be useful for food preservation and extension of shelf life. The efficacy of high antioxidant activity and antimicrobial properties of peel extract in prevention of the lipid oxidation and microbial growth in food products was reported by Chen et al. (2020). The antioxidant activity of pomegranate peel was reported to be higher than pomegranate juice due to the presence of high amount of total phenolics, flavonoids and proathocyanidins as compared to juice. The polyphenolic fractions of pomegranate peel powder is presented in Table 2.

The antimicrobial activity of peel extract is promising against antibiotic strain of methicillin-resistant *Staphylococcus aureus* and also effective against fungi including both pathogenic *(Aspergillus flavus)* and opportunistic pathogens. Elshafie et al. (2021) examined the antifungal activity against the phytopathogenic fungi, *Fusarium oxysporum, Phytophthora cinnamomi, Penicillium digitatum* and *Botrytis cinerea,* and the antibacterial activity was evaluated against *Escherichia coli*, Xanthomonas campestris, *Bacillus megaterium* and *Clavibacter michiganensis*.

Antimicrobial components from fruit peel helps to protect commodities from pathogens by penetrating to the cell of microorganism which causes lysis. Whereas, antioxidant properties improves the quality of the food as it improves the ability to prevent disease caused by oxidative stress. The stability and shelf life of food products can be prolonged by use of antioxidant agent which retards the oxidation of fat in food which otherwise deteriorate food and causes change in aroma, texture, and taste of food. The intervention of artificial compounds with antioxidant properties such as butylated hydroxy anisol (BHA) and butylated hydroxytoluene (BHT) etc. are limited in food product due to their carcinogenic effects. Due to the negative effect of artificial preservatives on health, there is growing demand for use of natural antioxidants in food industries.

In depth study on antioxidant properties of pomegranate peel was carried by Padmaja and Prasad (2011) and results revealed that, a total of nine phenolic compounds belonging to flavonols, flavones, tocopherol, derivatives of cinnamic and benzoic acids were identified by LCMS. Further, peel extract showed effectiveness to prevent rancidity was used as antioxidant agent in refined soybean oil. It could be a best alternative to synthetic antioxidant. Many researchers investigated that, peel extract is strongly effective against both gram positive and negative bacteria. The combination of peel extract with metal salt like $ZnSO_4$ enhanced the antimicrobial activity against

Table 2. Polyphenolic fractions of pomegranate peel powder

Sr.No	Polyphenolic fractions	mg/100g
1.	Ellagic acid	52.03
2.	Catechins	892.00
3.	Gallic acid	128.10
4.	Resocenol	14.09
5.	Protocatechol	4.62
6.	p-hydroxy benzoic acid	10.33
7.	Phenol	254.36
8.	Vanilline	4.17
9.	Caffeic acid	55.23
10.	Ferulic acid	6.11
11.	p-Coumaric acid	14.22

(Source: Omer et al., 2019)

Bacillus subtilis, Staphylococcus spp. and *Brucella* spp. The antibacterial, antioxidant and tyrosinase-inhibition activities of different cultivars of pomegranate fruit peel methanolic extract was studied and results revealed the significant higher radical scavenging activity in Arakta (83.54%) and highest phenolic content in Cv. Ganesh.

These compounds are gaining attention for its application in developing antimicrobials because of its health benefits. The non-toxicity dose of consumption for pomegranate peel extract has been reported by Elsherbiny et al. (2016).

The use of pomegranate peel extract as natural preparation to control plant and food borne pathogens associated with perishable fruits and vegetables has been reported (Belgacem et al., 2021). Recently, use of pomegranate peel extract in edible coating to extent shelf life of guava and capsicum (Nair et al., 2018) was reported. The pharmacological properties of pomegranate peel powder and its extract is mentioned in Table 3.

Pomegranate peel powder and its extract could be used as a natural food additives in place of synthetic additives particularly for extension of shelf life and enhance the nutritional composition with respect to biological active compounds.

The incorporation of peel powder and extract in perishable food products especially meat, fish and dairy based products where it will acts as antimicrobial agent and antioxidant.

But, there is need to standardize the cost effective technique for efficient extraction from pomegranate peel and more research required to know

Table 3. Pharmacological properties of pomegranate peel powder

Pharmacological activity	Details	Reference
Antibacterial	Methanolic peel extracts showed strong broad-spectrum activity against Gram-positive and Gram- negative bacteria, with the minimum inhibitory concentrations (MIC) ranging from 0.2 to 0.78 mg/mL.	Fawole et al., (2012)
Antioxidant properties	Antioxidant levels ranged from 1.8 to 6.8 μmol Trolox equivalent antioxidant capacity (TEAC) per gram bread for fresh bread. Addition of peel powder up to 2.5% w/w to wheat bread significantly increased its oxidative stability, with no effect on innocuousness as assayed with the brine–shrimp larvae assay.	Altunkaya et al., (2013)
Antihyperglycaemic, antihyperlipidaemic, and antioxidant properties	Peel extracts showed antihyperglycaemic and Antihyperlipidaemic activities from a powerful reactive oxygen scavenger through its antioxidant compounds. In addition, the peel extracts enhanced liver and kidney functions when compared to standard drugs in diabetic and hyperlipidaemic rats.	El-Hadary et al., (2019)
Antimicrobial	All of the fruit fraction extracts exhibited higher antimicrobial activity on *S. aureus* than *P. aeruginosa*, while *E. coli* was resistant.	Opara et al., (2009)

(Source:Magangana et al., 2020)

Pomegranate peel

Dried pomegranate peel

Pomegranate peel powder

the role and mechanism of peel powder and its extract as antimicrobial agent and antioxidant.

References

Altunkaya, A., Hedegaard, R. V., Brimer, L., Gökmen, V., &Skibsted, L. H. (2013). Antioxidant capacity versus chemical safety of wheat bread enriched with pomegranate peel powder. Food & Function, 4(5), 722-727.

Belgacem, I., Li Destri Nicosia, M. G., Pangallo, S., Abdelfattah, A., Benuzzi, M., Agosteo, G. E., &Schena, L. (2021). Pomegranate Peel Extracts as Safe Natural Treatments to Control Plant Diseases and Increase the Shelf-Life and Safety of Fresh Fruits and Vegetables. Plants, 10(3), 453.

Chen, J., Liao, C., Ouyang, X., Kahramanoğlu, I., Gan, Y., & Li, M. (2020). Antimicrobial activity of pomegranate peel and its applications on food preservation. Journal of Food Quality, doi. org/10.1155/2020/8850339.

El‐Hadary, A. E., & Ramadan, M. F. (2019). Phenolic profiles, antihyperglycemic, antihyperlipidemic, and antioxidant properties of pomegranate (Punicagranatum) peel extract. Journal of Food Biochemistry, 43(4), e12803, 1-9.

Elsherbiny, E. A., Amin, B. H., & Baka, Z. A. (2016). Efficiency of pomegranate (Punicagranatum L.) peels extract as a high potential natural tool towards Fusarium dry rot on potato tubers. Postharvest Biology and Technology, 111, 256-263.

Elshafie, H. S., Caputo, L., De Martino, L., Sakr, S. H., De Feo, V., &Camele, I. (2021). Study of bio-pharmaceutical and antimicrobial properties of pomegranate (Punicagranatum L.) leathery exocarp extract. Plants, 10(1), 153.

Fawole, O. A., Makunga, N. P., &Opara, U. L. (2012). Antibacterial, antioxidant and tyrosinase-inhibition activities of pomegranate fruit peel methanolic extract. BMC complementary and Alternative Medicine, 12(1), 1-11.

Kushwaha, S. C., Bera, M. B. &Pradyuman Kumar. (2013). Nutritional Composition of Detanninated and Fresh Pomegranate Peel Powder. IOSR Journal of Environmental Science, Toxicology and Food Technology, 7, 1(7), 38-42.

Magangana, T. P., Makunga, N. P., Fawole, O. A., &Opara, U. L. (2020). Processing factors affecting the phytochemical and nutritional properties of pomegranate (Punicagranatum L.) peel waste: A review. Molecules, 25(20), 4690.

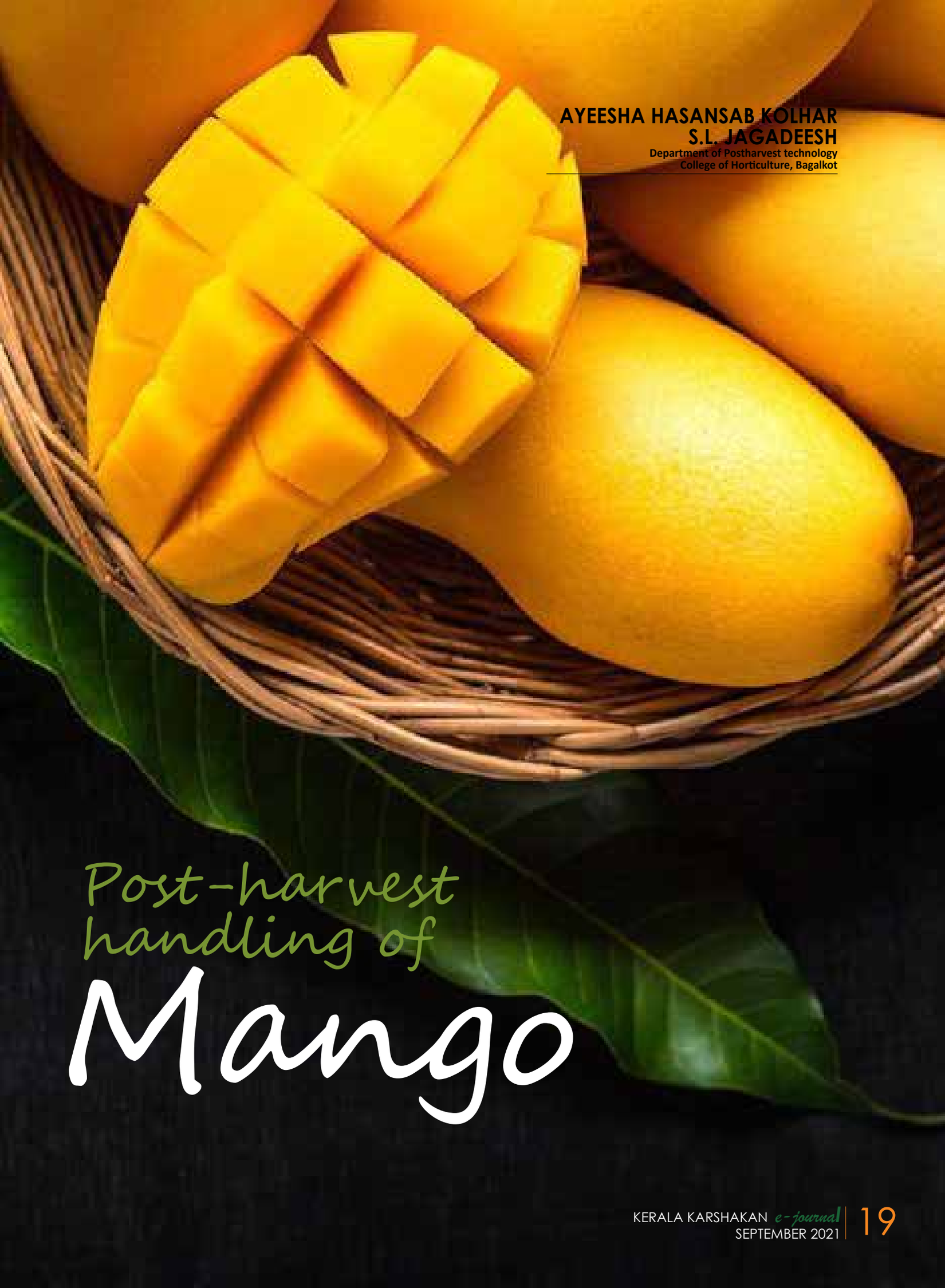
Nair, M., Saxena, Alok, Kaur, Charanjit. (2018a). Characterization and Antifungal Activity of Pomegranate Peel Extract and its Use in Polysaccharide-Based Edible Coatings to Extend the Shelf-Life of Capsicum (Capsicum annuum L.). Food and Bioprocess Technology. 11, doi.org/10.1007/s11947-018-2101-x.

Omer, Hamed A. A., Abdel-Magid, Soha S. &Awadalla, Ibrahim M. (2019). Nutritional and chemical evaluation of dried pomegranate (Punicagranatum L.) peels and studying the impact of level of inclusion in ration formulation on productive performance of growing Ossimi lambs. Bulletin of the National Research Centre, 43,182. https://doi.org/10.1186/s42269-019-0245-0.

Opara, L. U., Al-Ani, M. R., & Al-Shuaibi, Y. S. (2009). Physico-chemical properties, vitamin C content, and antimicrobial properties of pomegranate fruit (Punicagranatum L.). Food and Bioprocess Technology, 2(3), 315-321.

Padmaja, A., & Prasad, N. B. L. (2011). Pomegranate (Punicagranatum L.) peel extract as a source of natural antioxidant. Journal of Food Science and Engineering, 1(3), 171-182.

Pandey, R. M. & Upadhyay, S. K. (2012). Food Additive, Food Additive, Prof. Yehia El-Samragy (Ed.), ISBN: 978-953-51-0067-6, InTech, Available from: http://www.intechopen.com/books/food-additive/food-additive.



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Post-harvest handling of Mango

Mango *(Mangi fera indica L.)* is one of the most important and popular fruits of India known as the "king of fruits" because of its excellent overall eating characteristics. The fruit contains variety of phytochemicals and nutrients; it is high in dietary fibre, Vitamin C, provitamin A, carotenoids and diverse polyphenols. India is the major producer of mango in the world. Country is also well known for exporting the mango to foreign countries thereby contributing to the country's economy.

Huge after harvest losses in quantity and quality of mango fruits (or post-harvest losses) were noticed. Bruising and weight loss which represent loss in marketable weight are the other nature of losses. These losses can be attributed to poor harvesting, rough handling, and poor packaging and transport conditions. The high incidence of decay mainly in the form of anthracnose and stem end rot can be attributed to the high level of pre-harvest infection due to improper disease management during production. Thus, there is great need for following scientific postharvest handling for exploiting its commercial potential.

Harvest management practices

1.Maturity indices: Mango fruits harvested at the correct stage of maturity develop good peel and pulp color and have full flavor and aroma at the ripe stage.

Maturity indices used for harvesting mango are,

- **Shape** – flat shoulder at stem end; fullness of cheeks
- **Peel appearance** – presence of bloom (white powdery substance on the peel, change in peel color from dark to light green (for some varieties).
- **Pulp color** – light creamy yellow pulp.

2. Time of harvesting

The recommended time for harvesting mature fruits is from 9:00 a.m. to 3:00 p.m. to minimize latex flow.

3. Harvesting method: Mango fruits are generally harvested manually using a picking pole with net bag attached for catching the fruit once it is severed from

the branch. The harvested mangoes are then transferred to a collecting container that is lined with clean plastic or jute sack to prevent damage on the fruit. Plastic crates are the most suitable field containers. Harvesting tools and aids such as field containers must be clean to avoid contamination.

4. Post-harvest operations

Trimming: Trimming refers to the cutting of stem that is left on the fruit.

Delatexing/Desapping: Delatexing, also known as desapping, is the removal of fresh latex from the fruit. The steps involved are outlined below:

- Remove bagging material from the fruit. One advantage of bagging is that bags can provide immediate protection from latex staining during harvesting.
- Trim stem neatly close to the base of the fruit using sharp and clean pruning shears.

Note: Dipping freshly de-stemmed fruits in 1 percent alum solution (one-half kg powdered alum per 50 liters of water) for one minute. Alum enhances coagulation of the latex when fruits are dipped. Plastic crates can be used to hold the fruits during dipping. Allow fruits to dry before packing.

Sorting/grading: Sorting is the grouping of mangoes based on the criteria of the one classifying and there is no definite set of standards followed. This is the most common practice in selling mangoes. After harvest, mangoes are arbitrarily classified as "Class A" (good quality; for

export or for institutional buyers like supermarkets and hotels) or "Class B" (local grade or for domestic market).

Grading on the other hand, refers to the classification of mangoes based on the standard criteria accepted by the industry.

Post-harvest disease control: Anthracnose and stem end rot are the two most important post-harvest diseases of mango fruits. These diseases cannot be detected at the green stage and symptoms of infection appear only as the fruits ripen. An integrated pre- and post-harvest disease management protocol will ensure adequate control of these diseases. Hot water treatment of mango fruits at 52–55°C for 5 to 10 minutes will minimise the disease incidence.

Packaging and transport

Packaging: Proper packaging is essential in maintaining produce quality during transport and subsequent handling.

Transport: The main objective of transportation is to ensure that mangoes will arrive in good condition at the final market.

A good transport practices summarized below, must be followed:

- Handle containers gently; they should not be dropped or thrown on to each other.
- Containers at the bottom of the stack should not be used as steps to allow stacking to a greater height especially if semi-rigid containers like cartons are used.
- Allow air to circulate in the stacks or piles of packaged produce by providing space in between stacks.

Handling at wholesale and retail markets

The wholesale and retail markets serve as the outlets of mango farmers, collectors and other traders. The basic rules that should be observed are as follows:

- Unload containers from the transport vehicle under cover/shade with careful handling to minimize mechanical damage.
- Re-sort mangoes using sorting table.
- Discard culls properly.
- Re-grade mangoes according to size, appearance and stage of ripeness as the case maybe, depending on the requirement of the target market.
- Display mangoes on clean retail shelves or in clean containers
- When mangoes cannot be sold in one day, keep unsold mangoes in storage with proper ventilation.

Clump Rot
A menace in Cardamom

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Clump rot or Rhizome rot disease is caused by combined infection of three fungi viz., *Pythium vexans, Rhizoctonia solani* and *Fusarium sp.* Major symptoms of the disease are decaying of tillers starting from the collar region and finally toppling of the infected tillers. Affected tillers can be pulled off with ease. Discolouration can be seen at the basal portion of infected tillers. High atmospheric humidity coupled with intense rainfall, high soil moisture, high cloudiness and low air temperature are contributing to favourable condition for the infection to occur. Even during day time air temperature below 24°C during rainless days of rainy months (from July to November) along with the other environmental factors for a few days is ideal for the development of this disease.

In order to manage the disease, collection and destruction of the infected plant parts are recommended as a phytosanitary measure just prior to onset of south west monsoon. Excessive shade should be avoided during rainy months. Adequate drainage must be provided in the field having no slope gradient. The soil pH less than 5 favours the development of this disease. Lower pH levels are congenial for the rapid multiplication of this disease causing species. Therefore, liming is very important for

managing the disease. Lime materials (calcitic or dolomitic limestone) can be applied after testing the soil before the onset of the first monsoon. The fungal infection occurs through soil because the sources of pathogen are always present in the soil, especially in an endemic area where the disease prevalence is regular. When the pathogen load is increased to a certain level, the infection occurs quickly. Therefore, in order to reduce the load, application of bio control agents such as *Trichoderma viride* or *T harzianum*, *Pseudomonas fluorescens,* Mycorrhiza etc. is advised before the start of the first monsoon.

Trichoderma can be applied as basal @ 50g/plant or given as enriched form through dried cow dung and neem cake. *Pseudomonas flourescens* is recommended as 2% spray @ 20g/litre of water. At least, 5L of spray solution must be applied as drench at the base of the clump during pre and post-monsoon period. Mycorrhiza can be given @100g/plant as basal during planting time. When the disease is intense, it is advised to manage the disease with chemical fungicides, such as, copper oxy chloride @ 2g/ litre of water by drenching (5L/ clump). Further disease spread can be avoided by spraying 0.1% Carbendazim (50WP) or 0.1% Hexaconazole (5 EC). The disease is predisposed by the infection of root grub, mealy bug and plant parasitic nematode. Hence, adequate management measures have to be undertaken to prevent the infestation of these insect pests and plant parasitic nematodes.

Nearly 60% of the tillers in an infected clump will be damaged in severe cases. In an endemic area, it is very difficult to manage the disease. Hence, the farmers are advised to stay alert and manage the disease as and when it appears before causing too much damage to the cardamom clumps.

Partial Root Zone Drying Technique

A Water Conservative Approach for Dry Land Cultivation of Fruit Crops

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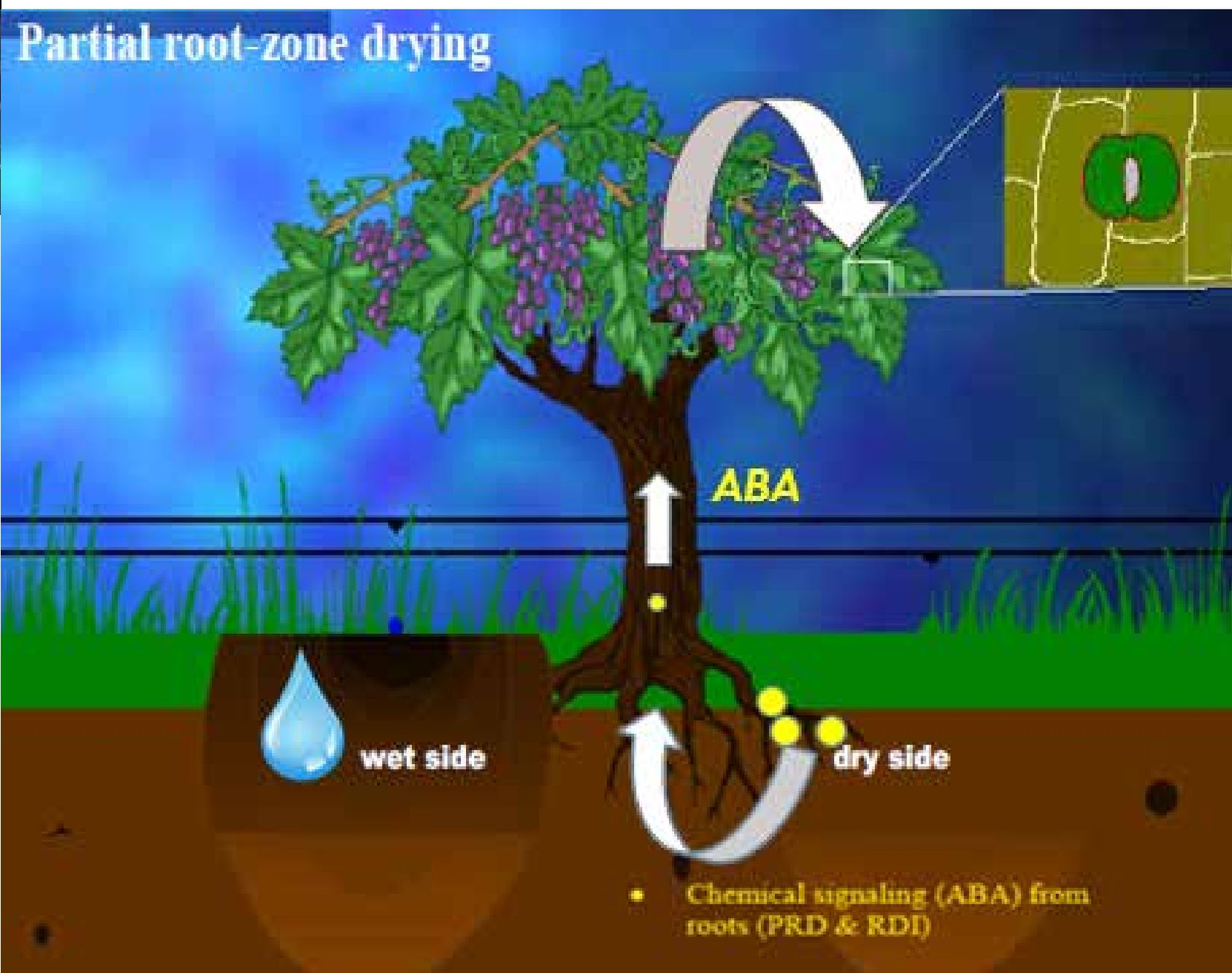
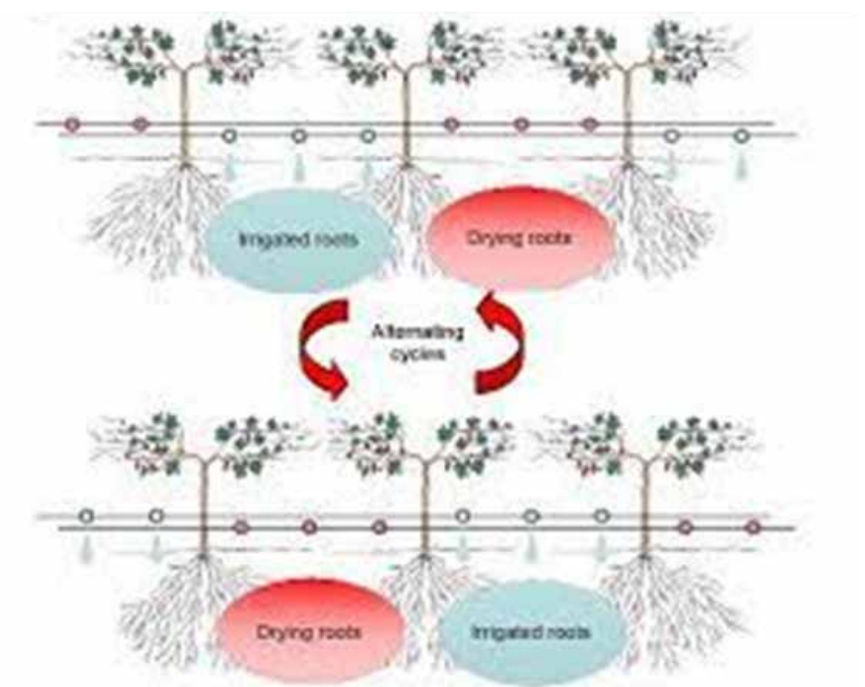


Partial root zone drying technique is a novel water saving irrigation technique used in arid and semi-arid conditions. This technique is mainly implemented for increasing irrigation water use efficiency and water productivity as compared to fully irrigated crop plants in areas where water resources are limited. Though PRD has not significantly affected the yield and quality attributes of fruits as compared to fully irrigated fruit crops, it is considered as a remedy for the orchards of dry land.

Climate change is the major obstacle in sustainable production of food. This change is majorly attributed by erratic rainfall and other biotic factors such as incidence of various pests and diseases. Drastically lowered rainfall leads to drought like condition in many regions of the country. Water is the key component through which plant takes nutrients with the help of a well-developed root system. In the absence of water, it becomes difficult for the root to absorb nutritional elements found in soil. Frequent occurrence of drought like conditions hampers agricultural production which includes food grains, oil seed crops, horticultural crops like fruits and vegetables. To achieve sustainable production even under stressful condition different technologies are need to be adopted. Hence to achieve the target of food security for 8 billion people by the end of 2025, irrigated area should be increased by more than 20% and the irrigated crop yield should be increased by more than 40% (Lascano et al. 2007). Partial Root Zone Drying is one of the best technologies implemented in orchards belonging to water scarcity zones. This PRD technique is being practiced for 10 years as better irrigating technique for dry land. In this method, one-half of the root system is forced into a drying phase while the other half is in irrigated phase (Kang and Zhang, 2004). This cycle should be altered after 10-15 days of treatment. This method was first implemented in cotton field (country – USA) by Grimes et al in 2008.

Deficit irrigation methods, wetting and drying of roots are dependent on crops, growing stage, evaporative demands, soil texture and soil water balance. Practically, it can be used in different ways depending on the cultivated crops and/or soil conditions, environmental conditions and method of irrigation most commonly used are seven, fourteen and twenty days. The dryness on one side leads to a decrease of plant transpiration without exhibiting symptoms of severe stress.

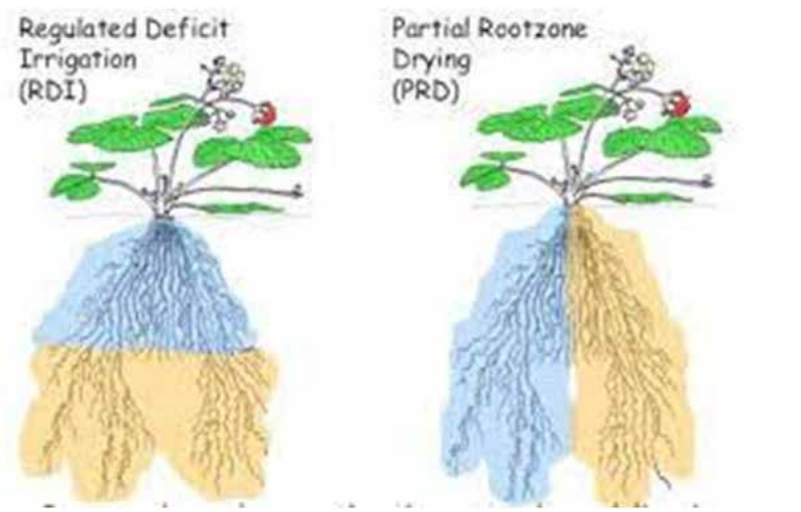


How does PRD work?

When the part of the root zone dries out, it increase the levels of abscisic acid (ABA) in the plant, that leads to the closure of stomata which reduces shoot growth and transpiration from the leaf surface.

Mechanism of PRD?

When soil water extraction from dry side is negligible, wetting should be changed from irrigated side to non-irrigated side. Furthermore, Liu et al. (2008) stated that switching should be based on threshold soil water content in which the maximum xylem abscisic acid (ABA) concentration is produced. ABA is a plant hormone that is produced in the roots in drying soils and is transported by water flow in xylem to the shoot for regulating the shoot physiology (Kang and Zhang, 2004).Therefore, in PRD roots



sense the soil drying and induce ABA that reduce leaf expansion and stomatal conductance and simultaneously the roots in wet soil absorb sufficient water to maintain a high water status in shoot.

In PRD, roots on the irrigated side absorb enough water to maintain high shoot water potential, and the roots on the non-irrigated side produce ABA for possible reduction in stomatal conductance. This mechanism optimizes water use and increase WP. Decrease in leaf expansion declines the use of carbon and energy, and a higher proportion of the plant assimilates is distributed to the root system and support further root development (Taiz and Zeiger, 2006). At mild water stress, ABA as a major chemical signal (CS) acts earlier than the change in plant water status (hydraulic signal, HS). However, under severe water stress, both CS and HS may be involved in regulating plant physiological processes (Ali et al., 1999). In some plants CS and HS occur independent of each other, while in others they take place dependently.

Tips for implementing PRD

- Best PRD responses occur in soils with high values of readily available water (RAW)
- PRD should not be used in soils with poor infiltration characteristics.
- The amount and timing of irrigation applied to the 'wet' side should be sufficient.
- The irrigated side of the plant should be switched when water extraction from the "dry" side becomes negligible.
- Correctly implemented PRD should not result in major effects on fruit quality.

Different ways for PRD application:

- Controlled alternate drip irrigation
- Controlled alternate furrow irrigation (AFI)
- Controlled alternate surface irrigation
- Controlled alternate sub surface irrigation

Advantages of PRD technique:

- Increases water use efficiency
- Increases the nutrient uptake
- Reduces transpiration rate
- Reduces excessive vegetative growth
- Improves fruit quality without reducing the crop level
- Drought tolerant deciduous plants respond best to PRD

Limitations of PRD

- Cost of implementing PRD irrigation system is high compared with traditional systems
- Lack of experiences about implementation of PRD irrigation system
- It does not respond well in shallow soils with low readily available water (RAW)
- PRD response is varying with species
- Lack of awareness about PRD irrigation method

Future prospects

PRD irrigation is in the research phase. Further research is needed to see the effect of PRD on yield and fruit quality gives the same results in both dry and humid climate and to evaluate economic advantages. Use of PRD under lateral move irrigators in combination with LEPA (low – energy precision – application). With an increasing demand for newer cultivars, higher density and different canopy architecture.

Conclusion

Partial root-zone drying irrigation (PRD) is the novel deficit irrigation strategy that is majorly adapted for fruit crops belonging to dry land agriculture. Key objective of this technique is to improve water productivity under depleting soil moisture conditions.

The amount of saved irrigation water and improved water productivity strongly depends on crop, soil and site specifications.

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Plants and weeds as Herbicides

Weeds are no strangers to man. They have been there ever since farmer started to cultivate crops in about 10,000 BC and undoubtedly recognized as a problem since the beginning. Any plant in the field other than his crop become weed. Again the characters of certain weed species are very similar to that of wild plants in the region. Some of the crops for example including the wheat of today are the derivatives of wild grass. In general, weeds are unwanted and undesirable plants that interfere with utilization of land and water resources and thus, adversely affect human welfare. In croplands, weeds compete with crops for natural resources such as light, water, moisture and nutrient which directly results in decreased yield as well as quality of produce.

Reduction of crop yield has a direct correlation with weed competition. Weeds compete for water, light, nutrients and space. Weeds compete for water in dry land and for nutrients in irrigated crops. It includes reduction in crop yields and production efficiency and erosion of crop quality. Reduction in crop yields and production efficiency is the

Sorghum

direct effect due to weeds. Beside the direct reduction in crop yields there are many indirect ways by which the weeds may be troublesome in agriculture.

For example, in weedy fields, management practices become cumbersome. Harvest may be difficult when the field is invaded with wild safflower *(Carthamus oxycantha)*, Canada thistle *(Cirsium arvense)* etc. which cause itching to the labourers. The weeds at harvest may increase the excessive wear and tear of the farm machines and increased cost of production to separate the weed seeds from the grain and other farm produce.

While chemical herbicides are often a familiar and effective solution for controlling weeds, the overdependence on a single solution can create resistance, leaving weeds unchecked. Increasing weed resistance threatens farmers' harvests and livelihoods, while also increasing agriculture's burden on the environment.

An eco friendly and environmentally safe method of weed management is the use of botanicals from plants, weeds and trees to control weeds. Here, the leachates, oils and alleochemicals from plants, weeds and trees are isolated and applied as herbicide as result of which plants are killed due to its allelopathic effect.

How the plants and weeds are used as herbicides?

a. Allelopathy
b. Crop residue
c. Catch crop
d. Trap crop
e. Intercropping
f. Crop rotation
g. Botanicals
(Trees and other plants)

A. Allelopathy

It refers to any direct or indirect, harmful or beneficial effect by one plant on another through production of chemical compounds that escapes into the environment.

Allelopathy is divided into two types:

1. True allelopathy
2. Functional allelopathy

The active substance may be released in any form from same plant organ (True allelopathy) or maybe released which is transformed into an active substance by more or less closely associated microorganisms (Functional allelopathy).

Source and routes of liberation of allelochemicals:

The allelochemicals involved in allelopathy occur in roots, rhizomes, stem, leaves,

Bottle brush pant

flowers, fruits and seeds. Leaves seem to be most consistent source of allelochemicals.

The allelochemicals are commonly liberated from donor plant by four general routes

1.Volatalization
2. Leaching
3. Exudation
4. Decomposition

Mechanisms of action of allelochemicals

Allelochemicals play a major part in the basic metabolisam of plants. They affect numerous physiological and biochemical process in plants such as

1. Inhibition of cell division and cell elongation
2. Inhibition of gibberellins or IAA/growth hormones
3. Mineral uptake
4. Retardation of photosynthesis
5. Inhibition of respiration
6. Inhibition of opening of stomata
7. Inhibition of protein synthesis and organic acid metabolism
8. Inhibition of activity of specific enzymes

Allelopathic plants as natural herbicide sources

Synthetic herbicides based on natural plant compounds are called as natural herbicides

Advantages

- New target sites
- Water soluble
- Perceived as more environmentally friendly

Disadvantages:

- Chemically complex
- Difficult to isolate and produce
- Not stable
- Expensive to synthesize
- Potential mammalian toxicity, carcinogenic, allergenic

Examples

Sorgoleone from sorghum, inhibits photosynthesis better than atrazine, but is short-lived and not stable.

Callistois a plant based herbicide the active ingredient of which is mesotrione. It is derived from a compound (leptospermone) isolated from the callistemon (bottle brush)

plant. It is commonly used to control broad leaf weeds in corn and fodder maize. It generally controls common rage weeds, *Chenopodium album* and velvet leaf.

Rape - turnip

Isolated compounds are allelopathic to several weeds like spiny sowthistle, may weed, smooth pigweed and barnyard grass germination. At higher concentrations, germination was completely eliminated.

Sorghum

Bottle brush pant

Allelopathic effect of weeds on crops (Examples)

1. Seed exudates of *Avena fatua* affect the germination and early growth of wheat.
2. Leaf and inflorescence of Amaranthus spinosa affect the vegetative growth of finger millet and maize.
3. Leaves and inflorescence extract of *Parthenium hysterophorous* affects the germination and seedling growth of sorghum

Allelopathic effect of crops on weed (Examples)

1. Root extract of maize inhibit the growth of *Chenopodium album* and *Amaranthus retroflexes*.
2. Cold water extracts of wheat straw reduces the germination and growth of *Ipomea spp*. and *Abutilon indicum*.

B. Crop residue

Crop residues are the plant parts remaining after the harvest of economic yield which for economic or social reasons are not fully utilized within the confines of production units and allowed to burden the natural environment. Some of the studies have shown that incorporation of crop residues into the soil affected the germination of weed's seeds.

For example, incorporation of sunflower stalk into the soil has affected weed seed germination to an extent of 50 percent as compared to without sunflower stalk incorporation. Similarly, incorporation of alfalfa reduces the germination of many weeds due to presence of allelochemicals called saponin, caffeine, chlorogenic acid, isochlorogenic acid, coumaric acid and ferulic acid in root exudates and residues.Therefore, we can use alfalfa as a natural herbicide.

C. Catch crop

Here, the crop is raised which favours the germination of parasitic weed seeds. Once the parasitic weeds germinate and start emerging, the crop is incorporated along with the weeds into the soil there by reducing weed seed bank in the soil of main crop.

Alfalfa plants

Green gram intercrop in maize

Eg: Growing of sorghum encourages the germination of striga. After few days of its emergence, incorporation of biomass in to the soil reduces the striga weed seeds in soil.

D. Trap crop

It is also similar to catch crop, where in a suitable crop is raised in order to stimulate germination of parasitic weed seeds. But due to non availability of host plants these weed seedlings die eventually.

Eg: Growing of cotton, cowpea, bengal gram etc., stimulates the germination of parasitic Striga seeds. However, the seedlings do not sustain in the field due to the non-availability of host plants.

E. Intercropping

Intercropping also helps in the control of many weeds in cropping system as well as parasitic weeds eg.Cuscuta in case of lucerne crop. Here, by growing two to three rows of cereal crops like maize, sorghum and bajra we can reduce its problem by restricting its movement from one plant to another.

Eg: Growing of green gram or white clover in sweet corn or tomato as an intercrop has shown a reduction in weed population up to 90% as compared to control.

F. Crop rotation

Crop rotationindirectly helps in the control of weeds. Here, the roots of previous crop exudates allelochemicals which affects the germination of weed seeds.

For example, when sorghum is rotated with alfalfa, it reduces the weeds population up to 30 percent. Similarly, wheat rotated with legume crop reduced the germination of Amaranthus spp., *Portulaca oleracea* and *Chenopodium album* etc.

G. Botanicals

Extraction of leachates, oils and allelochemicals from trees and other plants can be used as herbicides for controlling weeds. Eg: An alkaloid called 1, 3, 7-trimethylxanthise isolated from coffee seeds at various concentration affected the germination of many weeds like *Amaranthus spinosa, Avenafatua, Eichnachlolva colonum, Eichanachlova crusgalli, Vicia sativa* etc.

Spray of *Eucalyptus citridora* oil and leachates of *Cannabis sativa* affected the germination of *Parthenium hysterophorous* due to the presence of chemical compound terpenes.

Refractance Window

Dehydration Technology

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Drying / Dehydration is a complex process which occurs as a result of heat and mass transfer resulting in removal of moisture from food materials. The dried products are more stable to microbial contamination and other deteriorative chemical reactions, apart from facilitating storage and minimizing transportation costs. There are numerous drying methods such as drum drying, conveyor drying, spray drying etc., having their own advantage and disadvantage. Apart from all these drying

methods an attempt is made in this article to introduce an innovative novel drying method i.e., refractance window drying.

Refractance Window dehydration method was developed by MCD Technologies, Inc. (Tacoma, Washington) based on several years of research and development in novel water removing techniques. This drier can handle a diverse range of liquid products.Its practical application is to transform fruits, vegetables, herbs and other related products into value-added powders and concentrates. The technology is becoming attractive for applications in the food industry especially because the dried products are of very good quality and the equipment is relatively inexpensive.

The cost of refractance window drying equipment is approximately one third to one half that of a freeze dryer to dry a similar amount of product. The energy costs to operate RW dryers are less than half of freeze dryers. Contact drying methods such as drum or combined cylinder and belt drying (CBD) are probably the closest to RW drying.

Currently, RW drying technology is used to process products such as scrambled egg mix; avocado fruits for dips; high carotenoid-containing algae for treating macular degeneration and cancer; herbal extracts and nutritional supplements for human use; food ingredients such as herbs, spices and vegetables; and nutritional supplements for shrimp farming. For effective RW drying, the suspensions need to have the right consistency for ease of application and uniform spreading on the conveyor belt.

Refractance Window Drying and Food Quality

Retention of food quality in any drying operations is a must. So new dryers in food industry are targeted to optimize the conditions for retaining most heat labile compounds that plays vital role in quality retention of food. Many fruits and vegetables have been dried successfully using refractance window drying which resulted in retention of very good quality of the dried food product. These include carrots, squash, asparagus, blueberries, strawberries, mangoes, avocadoes etc.,

Microbial Reduction in Refractance Window Drying

Researchers have found that there is a significant decrease in the microbial count in RW dried products.The reduction of inoculated populations (106 CFU/mL) of coliforms and *E. coli* to an undetectable level is significant, which indicates that RW drying can result in production of safe products.

Advantages

- Lower installation and operation costs
- Shorter drying times
- No cross-contamination
- Requires 50 – 70% less capital and 50% less energy than thefreeze drier
- Reduction from 4 to 6 decades of microbial load
- Better quality of dried products

Limitations

- Low capacity of system
- Inconvenient to handle powders with high sugar contents

Conclusion

Refractance window drying technology can yield high quality (color, vitamins, and antioxidants)product in comparison to conventional drying methods. Thus RW drying technology can provide safe and good quality dried food products.

PROSPECTS OF GM RUBBER IN INDIA

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The world's first genetically modified (GM) rubber plants have been set up for field trial in Assam, India during June 2021. It is the second GM crop which started field trial in India next to Bt cotton. GM rubber is developed by Rubber Research Institute of India, Kottayam, Kerala, exclusively for North Eastern States. The genetically modified rubber trees are expected to survive better and yield more in the climatic conditions prevailing in that area.

What isGM rubber?

Rubber plant is a native of warm humid Amazon rain forests and suited for tropical areas. It requires a temperature above 25°C, humid climate, annual precipitation above 200cm. and rich, well drained soils. In NE India, growth of young rubber is retarded due to extreme winter climate when temperature falls to around 10°C, when the soil also gets dried up. During monsoon, the reduced light intensity also limits

crop growth. Lack of adequate water during summer also leads to osmotic stress. As a result, yield is reduced and maturity time is prolonged by over a year in the NE India compared to Kerala, the predominating rubber tract of India, which has more of a tropical climate.

Genetic modification (GM) implies transfer of desired genes for specific traits between species using laboratory techniques. The GM rubber is produced by inserting additional copies of MnSOD (manganese containing superoxide dismutase), an enzyme encoding gene. Multiple copies of MnSOD gene enable the GM rubber to surmount extreme climatic stress like hot and cold temperatures, drought conditions etc. Hence, the new rubber clone is also expected to reduce maturity period leading to early yield and reduced payback period, thereby enhancing the speedy returns.

Function of MnSOD genes

Superoxide dismutases (SODs) are metallo-enzymes that catalyze the conversion of superoxide molecules to hydrogen peroxide and molecular oxygen, thereby acting as cell's defense mechanisms against oxidative stress. Manganese containing superoxide dismutase (MnSOD) is an enzyme located in the mitochondria, the power house of cell. MnSOD is a nuclear encoded antioxidant enzyme that maintains normal mitochondrial functions by removing superoxide anion radicals generated in mitochondria and thus protects the cells from oxidative damage (Holley et al., 2011).

The MnSOD gene eliminates toxic oxygen accumulation in cells during extreme temperatures. Genomic DNA analyses of rubber have revealed the presence of MnSOD genes in several rubber tissues including leaf, root, latex and intact plants (Miao and Gaynor, 1993). These MnSOD genes were amplified using bio-techniques and reinserted into rubber plant cells in laboratory, which was further developed into rubber plants for field trial. Over-expression of MnSOD genes in GM rubber enhances the survival of rubber plants by reducing the oxidative damage of cells during physiological stress conditions.

Background of GM rubber

Genetic Engineering Appraisal Committee (GEAC), Ministry of Environment, Forest and Climate Change, Government of India, the country's apex biotechnology regulatory body had granted permission to start field trials of GM rubber as early as 2010 in Kerala. However, owing to the policy that Kerala preferred to remain a State free of GM crops, field level experiments were not undertaken in Kerala. The Rubber Board proceeded with the mission for climate tolerant GM rubber for NE India and succeeded by launching the field trial of GM rubber in Assam almost after a decade.

Prospects of GM rubber in North East India

India is currently the sixth largest producer and second largest consumer of natural rubber globally. The unique position of rubber in framing the economy of nation is undisputable. So is its unparalleled role in maintaining the oxygen balance by acting as a potential carbon sink in a predominantly fossil fuel consumer society. National Rubber Policy of India also promotes extensive cultivation of rubber to address strategic issues relating to climate change concerns and carbon market.

According to reports of Rubber Board, since there are no plant species in India that breeds with rubber trees in natural habitats, there is no risk of genes flowing from GM rubber into any other species, which is a concern often raised by environmental groups against GM plants.The apprehension of antibiotic resistance genes from GM rubber was also overruled as these genes would never come into contact with disease causing microbes. Field trials were also initiated by adopting all mandatory biological safety measures applicable to field trials involving GM crops.

References

Holley AK, Bakthavatchalu V, Velez-Roman JM, St Clair DK. Manganese superoxide dismutase: guardian of the powerhouse. Int J Mol Sci. 2011:12(10):7114-7162. doi:10.3390/ijms12107114

Miao, Z., Gaynor, J.J. Molecular cloning, characterization and expression of Mn- superoxide dismutase from the rubber tree (Hevea brasiliensis). Plant Mol Biol 1993: 23, 267-277

Moringa
Not to be Underutilized Anymore

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Introduction

Moringa is an essential part of South Indian cuisines for centuries. Around the world,the migrating south Indians are always nostalgic about the magnificent taste, flavor and aroma of Moringa. Moringa is also a prime ingredient of many Kerala recipes, especially dishes like Sambhar, Avial etc. Moringa is used as a vegetable for its edible pods, leaves and flowers. All parts of the plant such as, leaves, stem, roots, seed, bark, fruit, flower, immature pods have tremendous use in food industries, pharmaceutical industry, agriculture and cosmetic industry. Hence, known by several names such as Miracle tree, Global super food tree, Tree of Life, Magic tree, Vegetable tonic and so on. It is called as Drumstick tree (fruit resembles drumstick) Horse radish tree (taste of roots resemble horse radish), Ben oil tree / Benzoil tree (as Ben oil is extracted from seed).

Our ancestors, would plant 1or 2 Moringa plants in the homesteads which reveals the dependency of our forefathers on moringa for food and basic health care needs. Literatures also depict the importance of moringa in various traditional societies of Asia, Africa, Latin America, South America and Indonesia. In India also different indigenous and folk systems of medicine, make use of Moringa for several medicinal preparation. There is vast array of uses of Moringa in Ayurveda and Sidha medicines for the treatment of blood pressure, cholesterol, urinary tract infection, throat pain, stomach disorders, fevers, skin disease, bronchitis etc. Traditional claims of moringa have to be investigated by modern scientific world by undertaking further research.

World Health Organization has suggested Moringa as a promising food source to combat malnutrition. About 30 percent children in sub-Saharan Africa are protein deficient. Moringa could be an extremely valued food source for them. The climatic condition of most of the underdeveloped countries in African and Asian continent is suitable for the growth of Moringa. It can be prescribed to children, pregnant and lactating women (Moringa also known as mother's best friend). Due to its high iron content, Moringa is considered as a natural iron tonic and used for anemia. It is said that a woman's daily iron and calcium requirements can be met by moringa. Moringa can also help in dealing with lifestyle diseases like fatty liver, blood pressure, cholesterol, diabetics, rheumatism, ulcer, joint pain etc. *Moringa oleifera* Lam (2n=28) belongs to Family Moringaceae, originated in sub himalayan tracts of India and spread to other tropical and subtropical areas of world. The scientific name Moringa comes from tamil word "Murunggai'' or malayalam word ''Muringa''.

India, being the centre of origin, a wide variability exists in growth habit, flowering habit, fruit length, girth and color. Moringa grows fast even under minimum management and resources. It is adapted to wide range of soils but the soil should be well drained. The crop is adaptive and tolerant to adverse climatic condition especially drought and dry hot climate. Moreover, throughout the year the tree will be yielding any of its products either leaf, flower, pods, seeds etc.

India is the largest producer of Moringa in the world and the major contributors are Andhra Pradesh, Tamil Nadu and Karnataka. As far as Kerala is concerned, Moringa is an underutilized vegetable tree. Large scale cultivation has not gained much importance like other Moringa producing states. Even though it has multiutility, the cultivation of Moringa in Kerala is confined to 1-2 trees in homestead.

Nutritional Attributes and Medicinal Uses

Moringa as referred earlier is a nutrient rich vegetable and a good source of protein, vitamins, minerals, iron, essential fatty acid and phytochemicals. Vitamins like vitamin A,B, C, D and E is present in Moringa. Moringa has antibacterial,

antifungal, anti-inflammatory properties and used as antidote for insect bites. Nutrients present in Moringa helps in anti - aging and to boost our immune system. Every part of Moringa can be considered as a treasure of nutrients. Leaves are used as a source of nutrition and medicine and also an excellent source of green vegetable.

Apart from medicinal value, root, bark and seed also have industrial uses.

Moringa leaves contain more vitamin C than orange, more calcium than milk, more vitamin A than carrot, more potassium than banana, more protein than milk and iron contentis on par with palak.

Leaves are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper.

Vegetarians can use Moringa leaves as good alternative to meat because of high protein content. Leaves can be consumed as salad greens, pickles and as a seasoning. Moringa leaves being rich in fibre and lowin calorific value, can be recommended for diabetic and obesity patients. Antioxidants and bioflavonoid present in Moringa leaves can protect the body from free radicals. Thus, preventing or reducing the risk of cancer causing factors. Moringa leaves and small twigs are also used a fodder for cattle. Both dry and fresh leaves can be used as fodder. Studies revealed that substituting a portion of fodder with Moringa leaves would help to increase milk production and body weight in cattle. Scarcity of fodder during summer months can be met to some extent by using moringa leaves. Leaves can also be used as a protein supplement for poultry, rabbit, pig and fish in limited quantities Plant growth hormones present in the leaf extract can be used to increase growth and yield of vegetable and fruit crops.10% Moringa leaf extract can be used as foliar spray for crops. Seed when dipped in 30% Moringa leaf extract is found to increase germination rate. Moringa leaves can also be incorporated to soil as green leaf manure.

Pods are rich in protein and contain lipid, carbohydrate and fatty acid. Pods are good for digestive problems as it is rich in fibre. Flowers are rich source of Calcium and Potassium. Flowers and roots of moringa contain a compound called Pterygopermin which is supposed to have antibiotic and antifungal activities.

Nectar produced from flowers attract honey bees and helps in pollination. Moringa flower act as hypocholesterolemic and anti-arthritic agent. In ethanomedicine, flowers are used a wormicide, for kidney stone treatment and urinary problems.

Seeds are rich in fibre, calcium and zinc. Calcium is good for joint pain so good in arthritis and bone disorder. Zinc helps to regulates blood sugar. Seed is considered to have aphrodisiac property. Most valuble use of Moringa seeds is in waste water management i.e., as a organic water purifier. Purification of vegetable oil, honey and sugarcane juice clarification can be done with seeds of Moringa. Mature seed are roasted and used as snacks and used in different culinary preparations by boiling, frying, roasting etc. Seed cake is used as animal feed and green manure.

Edible oil (Ben oil) is obtained from seeds. Ben oil is a very good quality non-sticky vegetable oil, which contains 73% oleic acid, sterols and tocophenols. It can also withstand rancidity to a certain extent and is considered as a substitute to olive oil. As a vegetable oil, it is good for cooking specially for salad dressing. Seed oil has great cosmetic value and used in skin care products like moisturizing cream, anti-aging cream, lip balm, soap etc.Moringa oil is used for treatment of skin allergies and rheumatism. Seed oil is used for lubricating watches and fine machineries. Ben oil is used in the production of natural perfumes and fragrance. Exudates from stem is called Gum and is used in the treatment of tooth ache and also in calico printing. Gum obtained from stem mixed with sesame used to relieve headache.

Root Bark is also used for treatment of hernia in indigenous system of medicine. Root bark acts as a cardiac stimulant, anti-ulcer and anti-inflammatory agent. Roots are consumed as food in some African countries. However, not advocated as food as it contains some anti-nutritional factors and proper requires processing before consumption.

We can make use of Moringa tree in soil conservation also. It can be used for alley cropping, live fencing and the tree can also act as a wind barrier. Moringa is a soft wood tree which can be used as a source for pulp. From Moringa stem fibre, rope and mats can be produced. Natural dye is yet another valuable product obtained from moringa.

Value addition in Moringa

Value addition of Moringa has tremendous scope in domestic and foreign market. Moringa being highly perishable, value addition helps to enhance the shelf life. Medicinal and nutritive properties of Moringa can be used well in marketing value added products.

Another scope of value addition and product diversification is that it can yield additional income for farmers during glut period. Large scale moringa cultivation and value addition is at initial stages in Kerala whereas in Tamil Nadu, Andhra Pradesh, Karnataka value addition has become a big business. Different value added products of moringa are capturing the global scenario as a immunity booster and as a health supplement. Quality and hygiene is the primary requirement for value addition. Standardization of production, processing and storage protocols are also essential in all value added products of Moringa. Value added products should be properly preserved, packed and stored so that the multiple benefits of Moringa may not get reduced. Processing technology used for value addition should preserve natural flavour and aroma As the whole tree is packed with multinutrients, there is wide international market for all the parts of Moringa. TamilNadu, AndhraPradesh, Karnataka are the fore runners in export of moringa leaves. There is an inclination towards fresh green vegetable in edible form. Leaves are the main products of trade in local market. Fresh leaves can also gain more market abroad wherever South Indians live. Minimal processing

techniques can be adopted for these products. Since perishable shelf life depends on storage condition, packing etc. Fresh leaves are precooled at optimum storage condition and packed in ready to use form. As far as leafy vegetable is concerned, organic products will get better price. Hence organically produced Moringa will fetch high value in foreign market. Leaves are used to make pickles, sauce, chutney etc. Moringa canned leaves is yet another value-added product. Leaf paste, leaf juice packed in stand-up pouches can be used for mixing with Dosa and Idli. Leaf juice and paste should be stored under refrigerated condition.

Moringa leaf powder can be used as a natural food fortifier. The leaf powder is made by dryingor dehydrating the leaves inshade or artificial condition (Mechanical drying by using electric or hot air dryers /solar dryers/freeze drying techniques are there.) While drying quality standards should be maintained. In Moringa Solar drier are preferred now a days. Solar drying is superior to open drying because of better quality, maintenance of colour and hygienic. Dehydration we can improve the shelf life of Moringa without change in nutritional value. Except for Vitamin C, a very little nutrients is lost in the drying process. Advantage of dehydration is that dried leaves can be stored for longer time than fresh leaves and a year-round supply is ensured. Dried moringa leaf/ Dehydrated moringa leaf can also be marketed. Drying the leaves condense the nutrients so that a large dose of nutrients can be gained from a spoonful of dried leaf powder. For export, quality of powder determined by colour and texture. 10kg of fresh leaves when dried we get 1 kg of leaf powder. Leaf powder isused as food supplement to treat malnutrition, anemia and to flavor dishes. Leaf powder can be incorporated in several fruit mix, vegetable mix and spice mix and also in conventional dishes like dosa, idli etc. It should be finely powdered so that it can be added in any formulation or sieved to different mesh size according to use. Moringa leaf tablet / capsules is used as a substitute for iron tablet. It is another value-added product. Fortification of moringa powder with pasta, noodle, soups, sauces, sausages soup mix, cookies, health mix, and chocolate can capture foreign market. Leaf powder can also be marketed as a herbal dietary supplement.

Moringa leaf tea bags/ leaf cut and flower tea bags are two products of commercial importance. Moringa tea has a detoxifying effect and helps to reduce body weight. Can be consumed like green tea along with lemon and ginger. Seed kernels are dried and outer coat is polished to improve texture and appearance and marketed. Moringa seed oilis a good substitute to olive oil. 4kg of kernel is required for producing 1kg of moringa oil. Moringa honey which is produced from Moringa flowers have medicinal value.

Moringa dry flowers can also be produced. Dry flowers are powdered and flower flour is made. Flour can be used as soup mix, health mix, curry powder mixes etc. Pods/Fruits can be tinned, canned or made into chips. Dried Moringa pod can be used as an ingredient in Sambar powder.

CONCLUSION

Kerala is lagging behind in pursuing Moringa as an enterprise. Lack of knowledge in processing technologies, poor facilities and marketing channels are constraints in value addition and export. Organic protocols and good management practices are to be followed for export. Utilization of value-added product are limited in internal market also. Nowadays people spend more money for quality food products. Enormous attention is needed for value addition in Moringa as it helps to meet the nutritional and medicinal needs of a family and also opens a source for income generation. Large scale cultivation of Moringa should be promoted and emphasis should be given for setting up processing parks.

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Blue Tea

A wonder drink

The world is now moving in search of different immunity boosters for achieving resistance to health affecting factors. Several plants are being utilized for the preparation of herbal drinks that improve the health status of consumers like ginger, hibiscus, peppermint etc. The 'blue tea' is one among those drinks which is gaining popularity among users due to its wide benefits and appealing colour. This is prepared from the flowers, especially from the dried flowers of *Clitornia ternata*, commonly known as blue pea or "butterfly" pea in English and

"sankupushpam" in Malayalam. The blue pea is a perennial twiner, in Fabaceae family and is mostly found in the warm, humid regions of India. It is a commonly available creeping vine in our gardens of Kerala. Flowers are solitary, arising from the leaf axils with petals having varied colours ranging from dark blue or white or lavender or light pink. These petals are used for the blue tea preparation, especially from dark blue-coloured petals due to its appealing colour. In the traditional Indian systems of medicine, the roots, seeds and leaves of this plant have long been widely used as a brain tonic and is believed to promote memory and intelligence (Mukherjee et al., 2007).

This is not a newly accepted drink but has been consumed by people for ages, mainly from Thailand, Vietnam etc. The dried flowers are in huge demand in the online selling platforms as well as in supermarkets. It is mostly prepared by dipping clean petals of clitoria in hot water. For improving the colour from dark blue to purple, a few drops of lemon juice can also be added. Butterfly pea flower extracts are also used to add colour to various dishes and recipes. In Southeast Asia, the blue flower pigment is traditionally utilized as a food colorant because of the high stability. It is also added as a component in cosmetics.

Benefits of blue tea

There are several health benefits that have been recognized by drinking blue tea. It is absolutely caffeine-free and is enriched with antioxidants. Antioxidants help to reduce the damage caused by the free radicals which in turn decreases the risk of heart problems and diseases like cancer. Antioxidants in petals also make the skin look younger and healthier and so it is good for its antiageing property. The blue pea flower is excellent for hair growth as it contains anthocyanin (ternatins), a compound familiar to improve blood circulation in the head and maintain a healthy scalp. It also helps in strengthening the hair follicles from within, which results in thick and shining hair. It is also having an anti-inflammatory property because of the presence of flavonoids. This also acts as a memory booster, referred to as a brain tonic as it will refresh the brain and improves the activity of a neurotransmitter, acetylcholine. It is also used for reducing anxieties and therefore called as stress buster and relaxant. It is also helpful in improving eyesight. Another salient feature of this wonder tea is in aiding weight loss. This contains catechins which are useful for burning belly fat and reducing body weight. Catechin can speed up the metabolism and help to break down excess fat. Nowadays, obesity and excess weight are a serious issue among public health; therefore, drinking herbal teas will improve the metabolic activities in the body and reduceweight. This is also known to have a role in relieving cough, cold and asthma as well as in treating diabetes. These are some of the health benefits of this magic tea and still yet to be discovered.

The side effects of this tea have not been known. As it is a traditional medicinal plant, humans can consume it safely. But, if it is over consumed, it will results in problems like diarrhea, nausea etc.

Currently as people are very conscious about health, blue tea can be a better alternative for tea as it is free of caffeine as well as rich in healthy compounds. Therefore, this can also be included along with other herbal drinks like hibiscus tea, ginger tea etc.

References

Al-Snafi, A. E. 2016. Pharmacological importance of Clitoriaternatea–A review. IOSR J. Pharmacy6(3): 68-83.

Gupta, G. K., Chahal, J., and Bhatia, M., 2010. Clitoriaternatea (L.): Old and new aspects. J. Pharm. Res. 3(11): 2610-2614.

Kazuma, K., Noda, N., and Suzuki, M. 2003. Malonylatedflavonol glycosides from the petals of Clitoriaternatea. Phytochem. 62(2): 229-237.

Mukherjee, P. K., Kumar, V., Kumar, N. S., and Heinrich, M. 2008. The Ayurvedic medicine Clitoriaternatea—From traditional use to scientific assessment. J. ethnopharmacology120(3): 291-301.

Mukherjee, P. K., Kumar, V., Mal, M., and Houghton, P. J. 2007. Acetyl cholinesterase inhibitors from plants. Phytomedicine 14:289–300.

SUNCHOKES

An Underutilized Energy Yielding Tuber Crop

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Introduction

The Jerusalem artichoke *(Helianthus tuberosus L.)* is a member of the Asteraceae family. It's a tuber crop with a chromosomal number of 2n=6x=102 and a hexaploid chromosome number of 2n=6x=102. The Jerusalem artichoke is a perennial herb that is generally grown as an annual. The plant is a North American native.

Even though the plant is called the "Jerusalem artichoke," it is not from Jerusalem, and the word "artichoke" does not imply that it is a true artichoke. It's thought that Europeans named the plant Jerusalem after an Italian phrase girasole, then artichoke, which refers to the

artichoke-like flavour of tubers. Due to its superior environmental adaption, nutritional benefits, and wide range of pest and disease resistance, the crop was later disseminated throughout the Mediterranean and nearby areas. It currently covers the United States, Canada, Bulgaria, Russia, and a number of European countries. It is grown in Maharashtra, West Bengal, Assam, Uttar Pradesh, and Andhra Pradesh, among other states in India.

Botanical features

In many ways, the Jerusalem artichoke plant resembles a sunflower. The plant can reach a height of 5-8 feet and is mostly grown for the fleshy, edible tuber that resembles a potato. Tuber colors range from white to yellow, and from red to blue, with a weight of 80-120 g and a length of 75 cm. The flowers, also known as disc/capitulum, are tiny and yellow in hue. The leaves are hairy, alternating and oval in form. Jerusalem artichoke is a crop with a fast growth rate, high production potential, increased frost tolerance, no or low fertiliser requirements, drought resilience, and resistance to bad soil, such as excessive saline or alkalinity. It can grow in a pH range of 4.4 to 8.6 and can tolerate a wide range of temperatures. In sandy loam and even nutritionally deficient soils, the crop thrives. Temperatures of 18-26 degrees Celsius are ideal for growth, and the best months to plant are February-March or September-October. Harvesting the tubers after 5 months, when the stem is entirely senescent, is optimal. The yield of Jerusalem artichoke tubers ranges from 15 to 40 tonnes per hectare. Because the tubers have thin skin, they should be handled with caution to avoid bruising.

Varieties

Mammoth white French, Sutton's white (widely grown), V71, D1, D2, Patate Vilmorin, Comper challenger, Moder, Albik, Rubik. Being a less utilized crop, Jerusalem artichoke possess a number of economic threshold worldwide which it selves reveal the importance of conducting enough research and studies in this field.

Pharmaceutical potential of *Helianthus tuberosus L.*

Since time immemorial, the entire plant, particularly the leaves of the Jerusalem artichoke, has been utilised in folk medicine. They are used to treat swelling, pain, bone fractures, and skin wounds because they are considered to have antifungal, antibacterial, antioxidant, anti-diabetic, body mass lowering, anticonstipation, metabolism enhancing, and anticancerous effects. Apart from that, it also aids in the reduction of blood pressure and cholesterol levels. Two scientists, Anderson and Greaves, have confirmed that Jerusalem artichoke produces lactic acid in the form of D-lactic acid. Following that, multiple investigations by scientists such as Wang et al., Shi et al and others demonstrated that Jerusalem artichoke can invariably be used for lactic acid production, which can contribute more to the industrialization of this underutilized crop. Immune system abnormalities, chronic fatigue syndrome, cardiovascular illnesses, gastric mucosa, breast cancer, constipation, acne problems and other health issues may be prevented. This crop has exceptional immunostimulant and detoxifying qualities. As a result, the significance of Jerusalem artichoke in human health and well-being simply highlights the wide range of ways we might use the plant.

Jerusalem artichoke as a Functional food

A functional food is one that fulfils at least one additional purpose in the body in addition to the fundamental nutritional function. The inclusion of inulin, fructose, oligofructose, and other sugars in Jerusalem artichoke aids persons suffering from obesity and type 2 diabetes directly or indirectly. Inulin consumption has no effect on blood sugar levels since it is not digested until it reaches the large intestine. Inulin can also cause insulin to be released. As a result, replacing sugar, fat, and flour in dairy products, cereals, and baked goods with inulin is highly recommended for calorie reduction. Oligofructose, a short-chain polysaccharide, serves the same purpose as inulin in terms of nutrition and health. Inulin is primarily extracted on an industrial scale from chicory and Jerusalem artichoke, where we should be cautious about Jerusalem artichoke browning owing to PPO activity for quality inulin production. Pretreatment (slicing into small pieces), extraction (in hot water), and purification are the three key phases in the extraction of inulin (through bleaching by activated carbon). The inulin water is concentrated further and powdered. This powder can also be utilised as a raw ingredient in the production of a variety of food products. Several

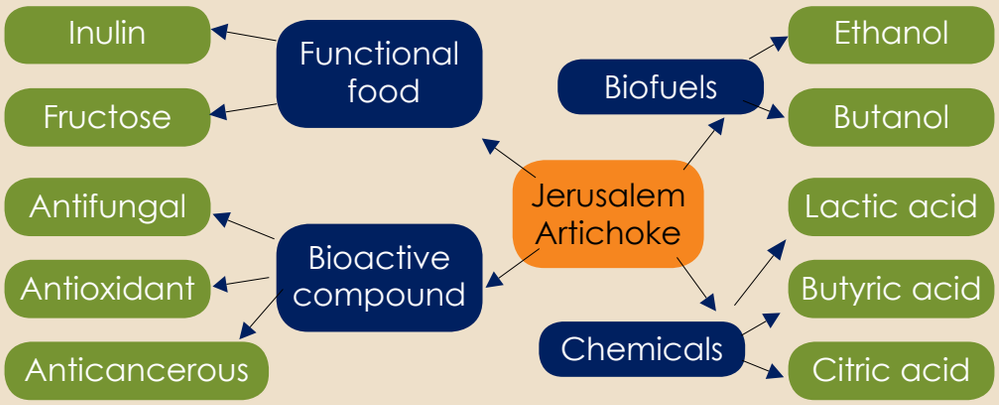

Fig.1 Applications of Jerusalem artichoke (Modified from Linxi Yang et al., 2015)

Jerusalem artichoke products, like as powder, capsules and others, are become increasingly popular in recent years. Similarly, fructose, which is present in the tubers of Jerusalem artichokes, is the monomer of inulin, which is used as a sweetener in medicines and functional foods. Because fructose has a lower glycemic index (23) than glucose (100) or sucrose (65), it will be a good replacement for diabetes people in the near future. As a result, Jerusalem artichokes find a lot of use as a functional food.

Jerusalem artichoke as an energy crop:

Because fossil fuels are rapidly depleting, it is critical to move to biofuels, which educate us about numerous energy plants such as maize, sugarcane, and, most recently, the Jerusalem artichoke, which was recently added by researchers. The Jerusalem artichoke is a good source of ethanol, butanol, succinic acid, citric acid and lactic acid as a raw material. Ethanol production in Jerusalem artichokes (yield L/ha) is 1500-11000 in tubers and 2835-11,230 in tops (Kays and Nottingham). Even though other disciplines have investigated the bioprocess of manufacturing butanol (ethanol), it is not commercially viable, and another key issue in this sector is determining whether food or fuel is more vital at the moment. Because the same plant fulfils multiple functions, we should place a premium on the plant for food notion.

Regardless of this fact, the inulin-rich tubers of the Jerusalem artichoke can be easily hydrolyzed and converted to ethanol with the help of biocatalysts, making it an excellent substrate for ethanol production. Separate hydrolysis and fermentation (SHF) and Simultaneous saccharification and fermentation (SSF) are the two most prevalent ethanol production technologies (SSF). The traditional approach involves converting inulin to fructose via acid hydrolysis and then fermenting ethanol using microorganisms (mainly *S. cerevisiae* and *Zymomonas mobilis)*.

Other applications of Jerusalem artichoke

Some research on Jerusalem artichoke has revealed the plant's natural ability to absorb heavy metals. According to the researchers, increasing the dose of sewage sludge enhances the output of artichoke, which raises the heavy metal level in the plant's above ground component. The Albik type of Jerusalem artichoke was found to be more suited in a study for the phytosequestration of heavy metals from sewage sludge supplemented soil. *Helianthus tuberosus L.* is a forage plant that can be used to replace corn silage in animal diets, as well as a cover crop in marginal areas and a sustainable biomass feedstock for biorefinery.

Fig.1 Applications of Jerusalem artichoke (Modified from Linxi Yang et al., 2015)

References

1. Koraris, N., G.P. Casentino, A. Wieczorek,and Z. Duvnjak, The Jerusalem artichoke as an agriculture crop, Biochemical and food engineering, The university of western Ontario, London, Ontario, Canada,1983
2. Adil Munim, Michel Rod, Hamed Tavakoli and Farah Hosseinian, An Analysis of the composition, Health benefits and future market potential of the Jerusalem artichoke in Canada, Carleton university, Canada,2017.
3. Linxi Yang, Quan Sophia He, Kenneth Corscadden, Chibuike c. Udenigwe, The prospects of Jerusalem artichoke in functional food ingredients and bioenergy production, Dalhousie University, Canada, 2015.

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