Department of Agriculture Development & Farmers' Welfare
Farm Information Bureau

Government of Kerala

SEPTEMBER 2022
VOLUME - 10
ISSUE - 03

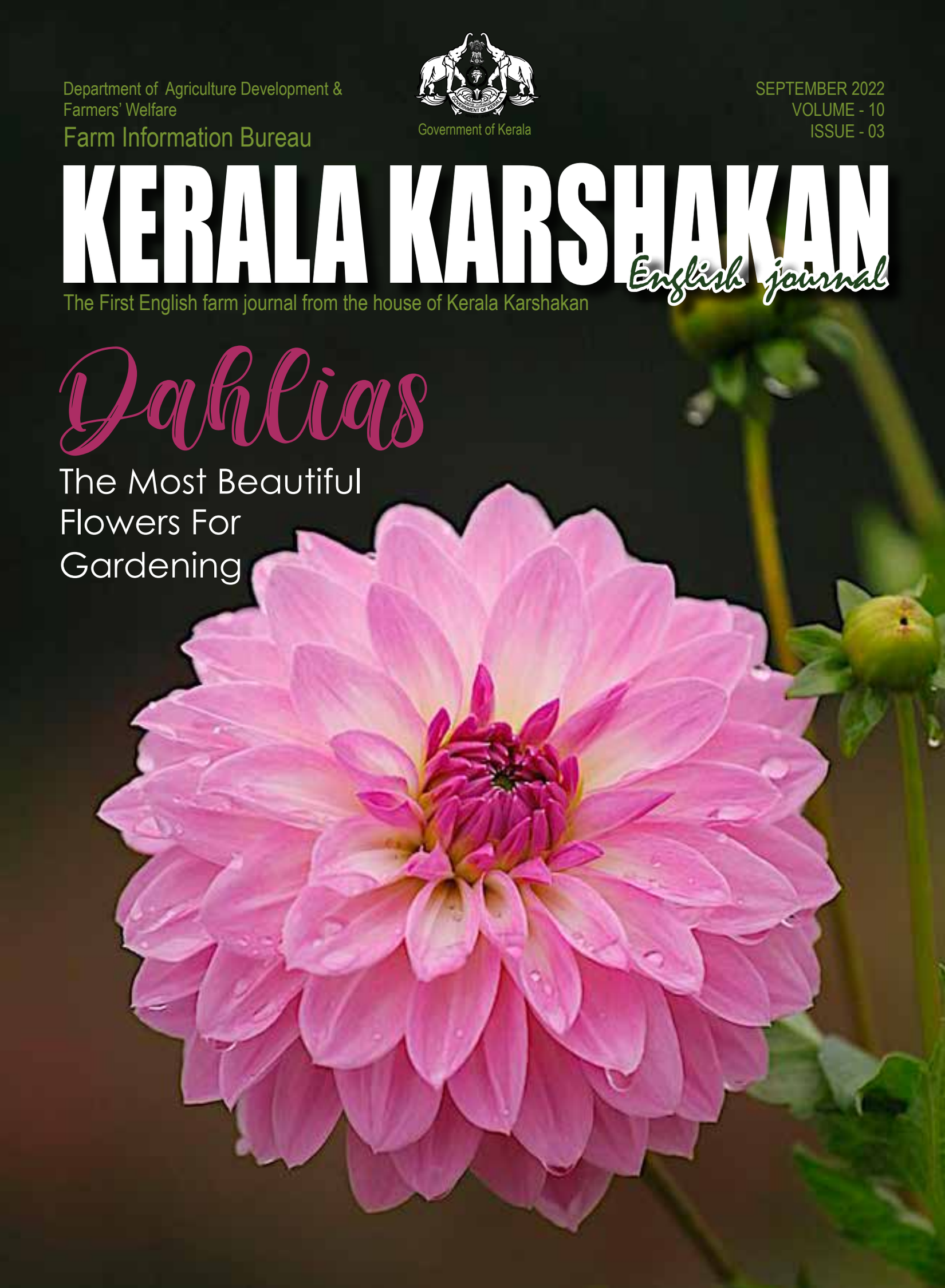
KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

Dahlias

The Most Beautiful Flowers For Gardening



INSIDE KERALA KARSHAKAN

English journal

SEPTEMBER 2022 Volume - 10 Issue - 03 Mail: editorejournalkkfib@gmail.com Log on to http://www.fibkerala.gov.in
Phone: 0471-2314358

The First English farm journal from the house of Kerala Karshakan

FARM INFORMATION BUREAU
ADVISORY COMMITTEE

CHAIRMAN
Ishita Roy IAS
Agricultural Production Commissioner,
Principal Secretary (Agriculture)

MEMBERS
T V Subhash IAS
Director of Agriculture
Department of Agriculture Development &
Farmers' Welfare

Dr. B. Ashok IAS
Secertary (Agriculture)
Department of Agriculture Development &
Farmers' Welfare

S. Harikishore IAS
Director (I&PRD)

Dr. A. Kowsigan IAS
Director (Animal Husbandry)

Director
Dairy Department

Station Director
All India Radio

Director
Doordarshan, Thiruvananthapuram

C Radhakrishnan
Chamravattom, Tirur, Malappuram.

Benyamin
Njettoor, Kulanada, Pandalam.

Baiju Chandran
Niravu Jaisree Buldings, Thycaud PO,
Thiruvananthapuram -14

Dr. Khadeeja Mumtaz
Chevarambalam, Kozhikkode

Alankode Leela Krishnan
Alankode PO, Malappuram - 679591

Muraleedaran Thazhakara
Pothannur, Krishnakripa, Thazhakara PO
Mavelikara, Alappuzha

Kariyam Ravi
115 Journalist Coloney, NCC Nagar,
Peroorkada,Thiruvananthapuram

Dr. Sajeed A.
Vilayil Veedu, Chanthavila, Sainik School PO
Kazhakootom, Thiruvananthapuram

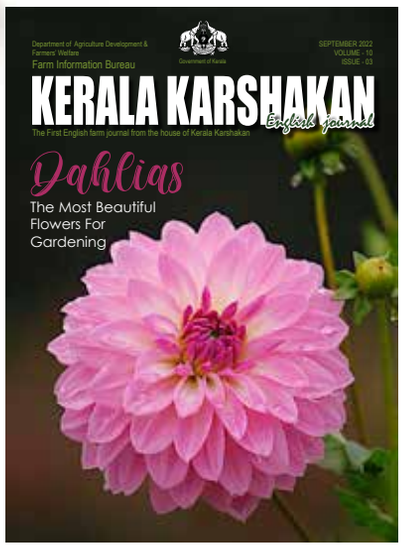
Suresh Muthukulam
Sarayoo, Bapuji Nagar
Pongumoodu, Medical College P.O
Trivandrum - 695011

CONVENOR
Suraj S
Principal Information Officer
Farm Information Bureau

ATTENTION AUTHORS

Articles for Kerala Karshakan e-journal should be certified by head of the institution concerned stating that the article is original and has not been published anywhere. Reference should also be included wherever relevant.

16



Chief Editor
Suraj S

Editor
Sreekala S

Asst. Editor
Reshmy P K

Editorial Assistant
Anoop R J

Design & Layout
Rajesh V

Articles/ Features appearing in this e-journal are either commissioned or assigned neverthless, other articles of farm relevance are also welcome. A maximum of 750 wordage is appreciated. Such items should be addressed to The Editor, Kerala Karshakan e-journal, Farm Information Bureau, Kowdiar PO, Thiruvananthapuram, Pin: 695003
These may also be mailed to editorejournalkkfib@gmail.com in word format. Responses can be also sent to this mail. Authors are requested to provide the following details along with the articles, for quick processing of the remuneration, after the articles are published: Account Number, Name of Bank, Branch (Place), IFSC Code.

VIEWS expressed in the articles published in KeralaKarshakan e-journal are not, necessarily those of the Government. Enquiries : 0471 2314358

[1]Pratheeksha, C. T
[2]Shilna Mukundan P. V
Ph.d Scholars
[1]Dept. of Floriculture and Landscape Architecture, College of Horticulture, Bagalkot
[2]Dept. of Floriculture and Landscape Architecture, KRC College of Horticulture, Arabhavi

Dahlias

The Most Beautiful Flowers For Gardening

It is commonly known as king of flowers and it symbolises dignity and elegance. Dahlia are one of the popular bulbous flowers found in most of the gardens. Multitude of colours, great variation in size ranging from miniatures(less than 2.5cm across), to giant (more than 40 cm in diameter),attractive shape, various forms, prolific flowering and easy cultivation have made them immensely popular. The genus Dahlia

named by Abbe Cavenilles in 1791.Dahlia is national flower crop of Mexico.

INTRODUCTION: The commercial value of this crop has been exploited in certain countries only. Netherland is the largest producer of this crop. Other countries which produce this crop at commercial scale are South Africa, U.K, Italy, Germany and U.S.A. The commercial cultivation of dahlia is limited in the hills and plains of Eastern India.

IMPORTANCE AND USES: They are extensively used in exhibition, garden display and home decoration Dwarf types are suitable for beds, borders and mixed border shrubbery. Large flowering dahlias grow in pots, terraced roof and verandah display. Long stemmed one is used for flower arrangement. Cut flowers of pompons, small and miniature type are most suitable for vases and also used for making garlands. Tubers of dahlia contain some medicines like, insulin, fructose, phytin& benzoic acid etc.

MORPHOLOGY: Dahlias are half hardy perennials with tuberous roots. Stems are mostly erect, branched, glabrous or scabrous. Leaves 1-3 pinnate, with slightly serrated margin, are produced opposite at each node on the stem. Bears flower on the long, stiff stem well above the foliage. Ray florets are neutral or pistillate and disc florets perfect. The fruits are achenes. Individual inflorescence is a raceme.

Species

- ***Dahlia coccinea:*** It is a highly variable taxon possessing both diploid (n=16) and tetraploid (n=32) races. Plants are slender, 0.4 to 2 meters tall, stems glaucous and pinnae(leaf let) arrangement on rachilla is opposite.
- ***D. pinnata:*** It is a tetraploid (n=32) species growth habit is quite similar to that of *D. coccinea*.
- ***D. imperialis:*** It is a diploid (n=16) species. Plants are 3 to 6 meter tall with woody stems. Pinnae arrangement on rachilla is opposite. Flowers are single, large, funnel shaped and lilac in colour. Also known as tree dahlia.
- ***D.tenuicaulis:*** This is also a tree-like species endemic in Mexico.
- ***D. merckii:*** This species possesses alternate pinnules on the rachilla of its compound leaves and hollow leaf petioles. Flowers are small and lilac in colour. Chromosome number is n=18.
- ***D. australis:*** This species has variable population with different chromosome numbers, n=16 and n=32.
- ***D. rudis:*** This species having chromosome number n=16 is about 5 meter tall with hollow and brittle stems and purple coloured flowers.

CLASSIFICATION: Dahlias are classified according to flower shape and arrangement of petals by National Dahlia Society of England.

I. SINGLE-FLOWERED: These have one row of petals, generally grow to 3 feet or less, and have flowers 4 inches (10 cm across) or less in diameter. Eg.Bambion, Little Dorrit, Pinnochio, and Yellow Hammer

II. ANEMONE- FLOWERED: Flowers have one or more rows of petals surrounded by a dense group of long tubular disc florets. Fully double flowers and good for flower arrangementEg. Comet, Guinea, Scarlet.

III. COLLERETTE: Flowers have one row of normal petals and one or more rows of small petals (the collar). Discs are apparent, very good for flower arrangement. Eg.Sincearity, Thais etc

IV. PAEONY FLOWERED: Flowers have two or more rows of generally flattened petals. Discs are apparent. Eg. Bishop of Landaff, Fasciation,

V. DECORATIVE: Have fully double flowers. The petals are broad, more or less flat or slightly twisty and wavy. The tips of the petals may either be rounded or pointed. It is the largest group among dahlias.

VI. BALL: Have fully double flowers. They are ball shaped or slightly flattened.

VIII. CACTUS: Have fully double blooms. Outer petals are narrow preferably with revolute

Dahlia coccinea

edges overlapping from the tips for at least two third of their length.

IX. SEMI CACTUS: Have fully double flowers. Like decorative dahlias the half base of the petal are broad and flat. The other half of the outer petal is revolute from the pointed tip for more than one quarter but less than half of the full length.

XI. FIMBRIATED: Fully double flowers. Petals are fimbriated from the tips preferably for at least 10 mm. Eg. Cherb Ami, Phenomenon, Lace maker

XII. WATER LILY: Flowers are fully double. Outer petals are broad and slightly cupped with rounded ends. From the side view the bloom are look like a saucer. Flowers resembles water lily (nymphaea). Eg. Christopher Taylor, Snowhill Rose, Island Dawn

XIII. STAR FLOWERED: Small cupid shaped flowers having two or three rows of pointed petals which overlap very slightly.

SOIL AND CLIMATE: Dahlias grow well in any type of rich and porous soil. They generally preferred well drained, deep fertile and moist soil with pH 6.5. An open and sunny place but sheltered from exposure of strong wind is ideal. A cool atmosphere free from frost is also necessary.

TEMPERATURE: Dahlia needs 10-21°C night temperature during winter. During summer it requires 15.6-26.7°C night temperature. Flower bud accelerated as temperature increases. The best quality blooms can be obtained at 25°C day, 16°C night. At 24°C day and 12°C night temperature delayed flowering.

LIGHT: Day length regulate flowering. 10-14 hours optimal for forcing flowering. 16 hours photoperiod or 4 hours night break. High light intensity is necessary for forcing.

PROPAGATION: Dahlia are propagated from seeds, tuberous roots, and cuttings, grafting and tissue culture also.

SEED PROPAGATION: Adopted for raising dwarf bedding singles and also for crop improvement. Thinly sow the seeds in shallow box or seed pan. Container contains porous soil, a layer of fine leaf mould. Takes 10 days to germinate at 18-28°C temperature.Seedling

FUN PICKS

Dahlias range from 1-inch minis to 12-inch (or more!) dinner plates. Here's a sampling of the 20 official forms.

WATERLILY
A more stocky plant, 'China Doll' produces 4-inch flowers that last awhile in vases.

POMPON
'Kasasagi' is a 3½-foot-tall variety with petite, compact blooms.

FORMAL DECORATIVE
Orange 'Maarn' and bicolor 'Zakary Robert' grow 4 to 6 feet tall. Good for backs of beds.

SINGLE
Daisylike in its simplicity, 'Bashful' is an early bloomer that grows to 3 feet.

ANEMONE
'Twilite' grows 4 feet tall, with pink pincushions crowning lavender florets.

COLLARETTE
'Pooh' has a "collar" of contrasting half petals—the signature of this type.

SEMI-CACTUS
'Little Missy' has dramatic quilled florets.

are ready for transplanting in 3-4 weeks period.

DIVISION: Tuber division may be used by separating tuber each with a piece of stem. Tuberous root required to place in a warm moist place for a short time before dividing the tuberous root.

CUTTINGS: Dahlias are commercially propagated by terminal cuttings. Cuttings of 7-8 cm with 1-2 pairs of leaves are prepared(sep-oct growth). The cut end is treated with IBA powder facilitate rooting

SOIL PREPARATION: Dahlias are generally cultivated both in pots and in ground. Dig the soil to a depth of 40 cm. Spread the FYM @ 5 kg/m2and pulverized. Mix with fork and make10 cm fine tilth Prepare before few weeks planting

PLANTING: Generally planted in September – October in the plains and in April in the hills. A spacing of 60 x 75 cm is practiced for tall, 30-45 x 50-95 cm for dwarf..

STAKING: Need immediately after they started growth. The new growth is soft and liable to affect by strong wind. Stem tied with jute string. Bamboo, polyethylene ring can be fixed in pompon around sticks or other small flowering types

MANURING: 50-80 : 40-60 : 60-100 kg of N, P2O5, K2O/ ha/year Half N + full P & K, as basal Half N at top dressing In a sand culture experiment on dahlia, it was found that high N and P is helpful in improving growth and flowering and K defeciency caused reduction in flowering Omission of any nutrients result as reduces the growth and flowering.

MULCHING: Dry grass clipping, old hay and saw dust are used for the purpose. Black polythene is very effective mulch.

PINCHING: Should be done as soon as 2-3 pairs of leaves appear. Pinched off at 15 cm tall – flowering delay 15 days Pinching at node 4 gave the best result. Pinching at node 2 delayed blooming and produced lowest number of flowers.

PRUNING: Thinning of shoots – keep bushes open Large decorative cultivars 4-5 main branches may be retained and small flowering type 8-10 branches.

DISBUDDING: To get the large blooms and for regulation of number of flowers it is must. All dahlia – excessive buds removed in very early stage

PLANT GROWTH SUBSTANCES:

Effect on flowering: Application of growth substances have proved very effective in the regulation of growth and flowering of dahlia by 6-15 days delay flowering. SADA @ 1000-5000 ppm, TIBA @ 500-2000 ppm and ethrel @2000 ppm increased flower production Ethrel 50-100 ppm, CCC, MH, SADH increased flower size.

Effect on tuberous root formation: CCC @ 2000-5000 ppm, ethrel 1000-5000 ppm increased number and weight of roots SADH application coincide with long day condition – promote roots. SADH + GA3 – inhibit roots. Early tuber formation – pre-planting soaking in ethrel 10 ppm

HARVESTING AND POST HARVESTHANDLING: Flowers are harvest during morning hours.

Yield: 8-10 flowers /plant. Cut the flowers along with long stem. Place immediately in a container half filled with water. Keep in cool & dark place for conditioning before packing. Pretreatment with boiling water for 30 seconds helps to maintain fresh quality up to 3-5 days Vase life (3-4 days) 8 days – 10% glucose + 0.2 mm AgNo3 + 8 HQS 200 PPM

LIFTING AND TUBERS STORAGE: When the plants are almost dried and colour of the stems turns to yellow. The plants are cut leaving only 15 cm stem from the ground. The tuberous roots are taken out with the help of forked hoe Allow the tubers to dry for 3-4 days in a shady place. Before storage the tubers have to be treated with 0.2% captan for 30 minutes Slurry treatment may be done.

They can be stored on sand floor in a cool place for several months. The ideal storage temperature should be between 4°C to 7°C

DISEASES:

Powdery mildew: *Erysiphe*

SEED

cichoracearum.

To control the disease the plant should be dusted fortnightly with sulphur dust, or sprayed with wettable sulphur, dinocap, benomyl and carbendazim

Stem rot: This disease is soil borne in nature and is caused by *Sclerotinia sclerotiorum* and *Sclerotium rolfsii* for control, the tubers are treated in benomyl (0.1%) for 30 minutes after harvest and before planting.

Bacterial wilt: Plants infected with *Pseudomonas solanacearum* usually droop and wilt suddenly. Destruction of all wilted plants should be done. Crop rotation.

Bacteriosis: This disease caused by *Erwinia carotovora* var. carotovora.This disease also affects tubers. Destruction of the affected parts of the plant should be done so as to prevent the spread.

Mosaic virus: Mosaic is caused by *Marmor dahliae*. Careful selection and multiplication from symptomless plants is essential.

Spotted wilt: Spraying of 0.1 % malathion or metacid to control insect vectors is recommended. Using virus free tubers or cuttings can also check the disease.

INSECT PESTS

Aphids: Three different aphids infest dahlias viz., Bean, Green Peach and Leaf-Curl Plum aphids. Spraying with metasystox or malathion (0.2%) as soon as the aphids appear and frequent tilling of the ground kills off the aphids.

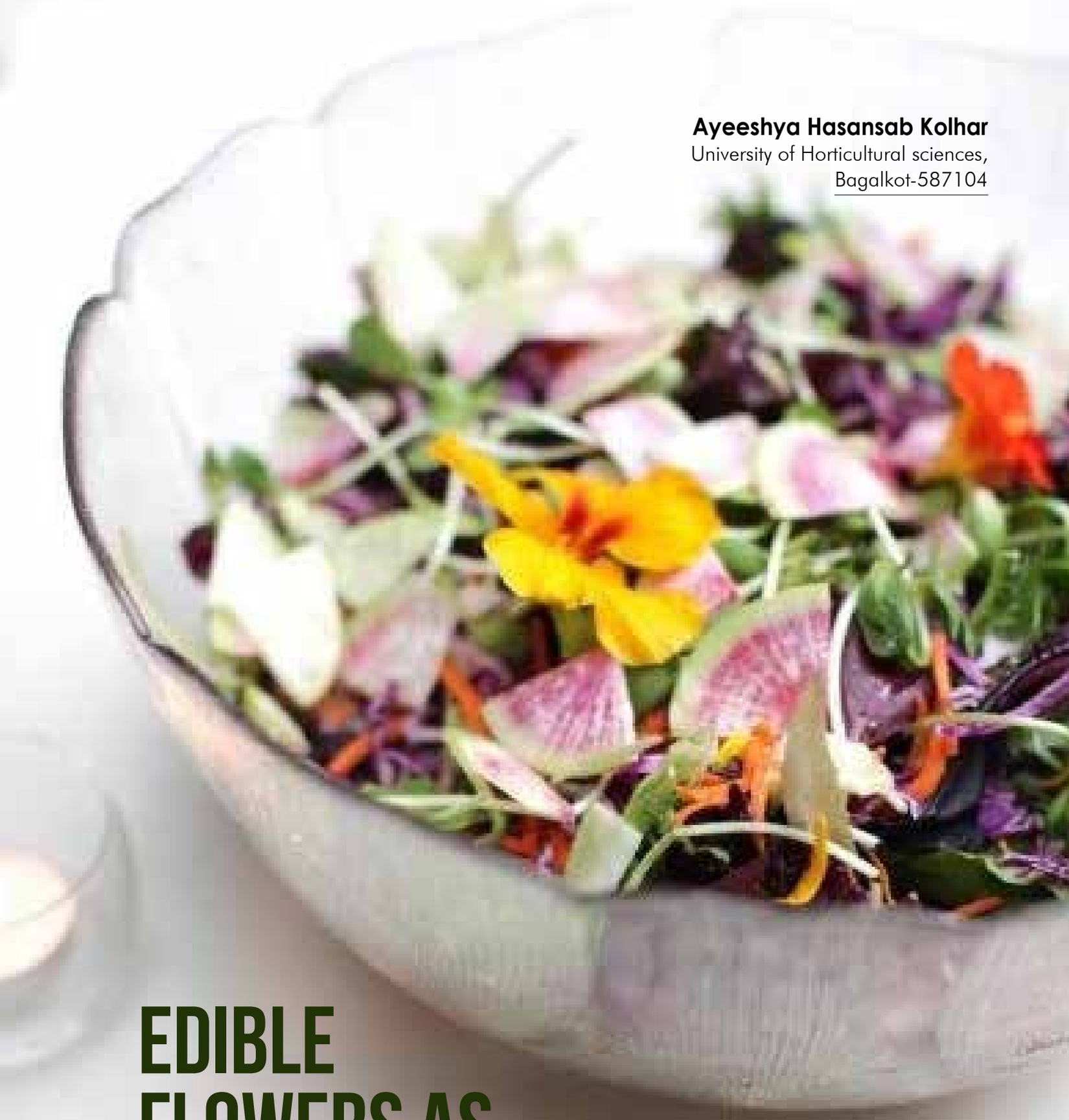
European corn borer: The larvae of borers *Ostrinia nubilalis* feed on the tender bud ends, flower parts and leaves causing them to become destored and turn brown.

For control dahlias should be sprayed with a mixture of sevin (0.2%) and kelthane (8 ml/ 10 lit). Other Insect pests are leaf hoppers, thrips and mites.

Nematodes

Root knot nematode: Two root knot nematodes (*Meloidogyne incognita and M. hapla*) occur on the roots of dahlias when plants are grown in infested soil.

Ayeeshya Hasansab Kolhar
University of Horticultural sciences,
Bagalkot-587104



EDIBLE FLOWERS AS PART OF HUMAN DIET

Edible flowers, have been used in the culinary arts for centuries, are experiencing renewed popularity. Flowers can serve as an essential ingredient in a recipe, provide seasoning to a dish, or simply be used as a garnish.Flowers are part

Garden anchusa and Italian bugloss

Cotton tree

Orchid Tree, Purple Butterfly Tree

Marigold or Scotch marigold

of many regional cuisines, including Asian, European, and Middle Eastern cuisines. The ancient Romans cultivated roses, violets, and borage for culinary use. Today, edible flowers are a popular way to add colour, texture, scent, and flavour to foods. Following is a list of some edible flowers, their culture, and suggested uses.Thereare numerous edible flowers all over theworld and detailed information is muchneeded in order to increase theiracceptability as food ingredients and to avoidpotential risks

Edible flowers

Garden anchusa and Italian bugloss *(Anchusa azurea P. Mill.)* Flowers are in violet lightblue colouration and belongs to Boraginaceae and used in preparation of soups, boil, fries and salad and it is also depurative, antitussive, diaphoretic, and diuretic

Cotton tree *(Bombax malabaricum L.)*

Flowers are in orange and red colours, belongs to Bombacaceae family. Those are cooked and accompanied with meat and rice and also used in treatment of chronic inflammation, fever, diarrhoea, hepatitis, and contused wounds Snapdragon (Antirrhinum majus L.): Flowers are in red, rose, white colours and belongs to Plantaginaceae. It is mostly used as salad and widely used in antiphlogistic, resolvent andstimulant; liver disorders, treatment of scurvy, tumours and also used as detergent, astringent and diuretic

Orchid Tree, Purple Butterfly Tree (*Bauhinia purpurea L.*)

Flowers are purple in colour and belongs to Leguminosae. It is used in salads and also nephroprotective and thyroid hormone regulating, antibacterial, antidiabetic, analgesic, anti-inflammatory, anti-diarrheal and anti-tumor activities

Marigold or Scotch marigold *(Calendula officinalis L.)*

Flowers are orange in colour and belongs to Asteraceae. It is used in salads, omelettes or as an accompaniment cheese. The flowers posses antioxidant, anti-inflammatory, antitumor, anti-edematous, anti-HIV, antibacterial and antifungal activities, immunomodulatory and immunostimulating, spasmolytic, spasmogenic and gastroprotective, insecticidal, heart rate decrease, cardioprotective, genotoxic and antigenotoxic dose dependent.

Flinders rose *(Capparis spinosa L.)*

Flowers are white-violet in colour and belongs to Capparaceae. It is preserved in vinegar and salt and salad. It is antiseptic, diuretic, and protective of capillary vessels

Safflower *(Carthamus tinctorius L.)*

Flowers are red in colour and belongs to Asteraceae. It is used in infusions and cakes and restoring menstrual flow and promoting blood circulation

Cornflower and bachelor's button *(Centaurea cyanus L.)*

Flowers are blue in colour and belongs to Asteraceae. It is used to make infusions, garnish and natural food colorant. It has antioxidant activity, soothing, and used in ocular inflammation Florist's daisy and hardy garden mum (Chrysanthemum morifolium Ramat) Flowers

are yellow-white in colour and belongs to asteraceae. It is used to make infusions and cakes. It has detoxifying and heat clearing effects

Chicory
(Cichorium intybus L.)

Flowers are light blue in colour and belongs to asteraceae. It is used in soup, boil, potage and salad and it has depurative, diuretic, laxative, hypoglycaemic, disinfectant of urinary tract and hepatoprotective

Gardenia, cape jasmine, cape jessamine, danhdanh and jasmin *(Gardenia jasminoides)*

Flowers are white in colour and belongs to Rubiaceae. It is used in infusions and soup and promoting diuresis and heatclearing

Sweetvetch *(Hedysarum coronarium L.)*

Flowers are purple in colour and belongs to Fabaceae. It is used in soups, fries with eggs, and salad and hypocholesterolemic and laxative effects

Chinese hibiscus *(Hibiscus rosa sinensis L.)*

Flowers are rose in colour and belongs to Malvaceae. It is used as infusions and foodsupplement and cures genitourinary troubles, bronchial catarrh, fever and cough

Roselle
(Hibiscus sabdariffa L.)

Flowers are red in colour

Chicory

Gardenia, cape jasmine, cape jessamine, danhdanh and jasmin

Sweetvetch

Chinese hibiscus

Roselle

Arabian jasmine and Sambac jasmine

Japanese honeysuckle

Johnny Jump up and heartsease

and belongs to Malvaceae. It has flavouring agents, beverage (hot and cold), jams preparation of herbal drinks, fermented drinks, wine, ice cream, chocolates, puddings, cakes and it can cures hypertension, abscesses, dysuria, fever and scurvy

Arabian jasmine and Sambac jasmine *(Jasminum sambac L.)*

Flowers are white in colour andbelongs to Oleaceae. It is used as infusions and also in porridge and it cures skin diseases, cancer, uterine bleeding, ulceration, leprosy and wound healing.

Japanese honeysuckle *(Lonicera japonica Thunb.)*

Flowers are yellowgreen in colour and belongs to Caprifoliaceae. It is used as infusions and in soup and its also heat-clearing and detoxifying

China rose and Chinese rose *(Rosa chinensis Jacq)*

Flowers are red in colour and belongs to Rosaceae. It is used as flavour extract, jams and infusions and also cures homeostasis, menstruation disorders, trauma and diarrheal

Garden nasturtium *(Tropaeolum majus L.)*

Flowers are yellow. orange, red in colour and belongs to Tropaeolaceae. Used as ingredients in meals, salads, foodstuffs and drinks. Antibacterial, antitumor and antithrombotic activities, diuretic and hypotensive effects are medicinal uses

Johnny Jump up and heartsease (Viola tricolor L.)

Flowers are yellow, orange, purple, violet in colouration and belongs to Violaceae. It is used in food

Table: 1 Edible flowers and their benefits

Flinders rose

Safflower

Cornflower and bachelor's button

Sl.No	Narne of the Edible Flower	Benefits
1.	Chives, Signet marigold, Nasturtiums, Portulacas, Purslanes, Rose	Rich in Vitamin-C
2.	Dandelions	Source of Vitamins A and C and the greens are high in calcium, iron and phosphorous.
3.	Calendula and elderberry blooms	Aid digestion, reduce fevers and stimulate the immune system.
4.	California poppies, Chamomile and Lavender	Ease stress and work as gentle sleep aids.
5.	Goldenrod	Relieve allergies and urinary tract infections, and aids in digestion
6.	Hibiscus	Contains antioxidants that help prevent cholesterol deposits and aids liver disorders.
7.	Honeysuckle and Hyssop	Relieve respiratory problems and soothe the stomach and colon.
8.	Mullein	Help respiratory ailments, pain and headaches and induce sleep, nasturtiums contain natural antibiotic properties
9.	Red clover	An excellent blood purifier and make a wonderful tasting tea
10.	Violas and violets	Anti-inflammatory properties and are good for respiratory ailments, and yarrow heips relax blood vessels and reduce fevers and colds.

colorants, sweets, salads, soups, vinegars and drinks and also used in prevention in Alzheimer, Parkinson, atherosclerosis and various cancers; antiallergenic, antiatherogenic, antiinflammatory, antimicrobial, antioxidant, antithrombotic, cardioprotective and vasodilator effects

Conclusion

Edible flowers are widely used to add colour and enhance the visual appearance of various dishes, having special interest in culinary and for the food industry.

Are appreciated by their nutritional characteristics, associated to a low in fat content, energeticvalue, and can also be sought as a natural source of bioactive compounds, such as phenolic compounds, which may play an important role in health promotion and disease prevention.

Ms. Suma Madhavan
Dr. Jalaja S. Menon
KeralaAgricultural University.

Black garlic

Taste the sweetness in pungent garlic

Garlic *(Allium sativum)* is the second most widely cultivated Allium after onion. Globally, India ranks second in garlic production after China. Garlic has long been recognized all over the world as a valuable spice and

a popular remedy for various ailments. The physiological effect of garlic is mainly due to the presence of volatile sulphur compounds like thiosulfates, which give its characteristic pungent aroma. Even though the health benefits of garlic are known, people are reluctant to eat raw garlic due to its pungency. Hence there is great interest in developing fermented garlic and its products which improves its taste and aroma. The color of garlic changes to dark brown or black and hence it is popularly known as black garlic.

Black garlic

Black garlic is obtained from fresh garlic that has been fermented for a period of time at a controlled high temperature and high humidity without any artificial treatments or additives. When compared with fresh garlic, black garlic does not release a strong offensive flavor owing to the reduced content of allicin. Enhanced bioactivity of black garlic compared with that of fresh garlic is attributed to changes in physicochemical properties.

Black garlic is utilized today for its distinct flavor and texture as a gourmet ingredient and is fast becoming popular for its exceptional nutritional value that supersedes the raw garlic in some aspects.

History of black garlic

Black garlic has a long history of use as a medicinal and culinary super food in several Asian countries primarily in Japan, Korea and Thailand. It often claimed to have originated in Japan where the process was thought to have been developed. In 1999, the miracle vegetable with multi-biological functions "Black garlic" was produced by a Japanese Mr. Kamimura which revolutionized the food world. It was having the characteristic sweet taste of a fruit, no pungent odor and directly edible just after peeling off outer coat. Black garlic has gained popularity in Japan after a research published its health benefits in 2006. The number of the black garlic companies now exceeds 500 in Japan.

Production of black garlic

Black garlic is produced through the natural aging of whole ordinary garlic under controlled conditions of high temperature (60-90^{0}C) and humidity (40-90%) for several days (10-90), without any artificial treatments or additives. Black garlic is produced by fermentation of whole bulb of fresh garlic at high humidity and temperature, which turn white garlic to black. Thermal processes are commonly used in food manufacturing to enhance the sensorial quality of foods, their palatability and to extend the range of colors, tastes, aromas and textures in food. In addition, heating processes have led to the formation of biological compounds that were not originally present in food.

The production of black garlic in this manner is not a microbe-associated fermentation, but a Maillard and Browning reaction as the processing temperature of garlic does not allow bacterial growth to elicit fermentation. Good quality raw garlic is subjected to fermentation and it involves initial, mid fermentation and final maturity stages. Maillard reaction will takes place in initial stage. Oxidation of phenols and caramelizing will take place in mid stage and maturity stage. Maturity stage is indicated by its spongy soft and chewy texture, similar to dried date or fig.

Maillard reaction is one of the major processes during the black garlic formation. Color

Fig. 1: Production process of black

The typical compositional changes that take place during production of black garlic are shown in the table.

Content	White garlic	Black garlic
Reducing sugar	5.90 g/ kg	472.40 g/ kg
Organic acid	16.68 g/ kg	64.18 g/ kg
Polyphenol	38.87 mg GAE/ g	68.95 mg GAE/ g
SAC (S- allyl cysteine)	19.61 mg/ g	105.07 mg/ g
5 HMF (5- Hydroxy Methyl Furfural)	Not detected	0.23 g/ kg
Allicin	11.28 g/ kg	2.31 g/ kg
SOD (Super Oxide Dismutase)	12.96 g/ kg	Not detected

change from white to black is mainly due to this important reaction. The Maillard reaction is a non- enzymatic reaction between reducing sugars and the amino group in amino acids, peptides and proteins. It involves reaction between lipids and sugars with amino acids in garlic and produces a variety of intermediaries. Melanoidin and other brown polymer compounds produced from the Maillard reaction give good characteristics dark brown color. The non-enzymatic reaction taking place during fermentation result in sweet taste and brown or black color. It converts the simple sugars into maltose, sucrose, glucose and fructose. Several studies were conducted for enhancing the flavor of black garlic. The compound responsible for the flavor of black garlic is 5-HMF (5-Hydroxy Methyl Furfural). Pre-treatment methods, fermentation temperature and fermentation humidity have a vital role to enhance the flavor of black garlic. The best fermentation temperature was 61.8°C and the best fermentation humidity was 40.2%.

Changes occurring on formation of black garlic

Thermal process and relative humidity cause modifications in the typical composition of the fresh garlic during the production of the black garlic. During heat treatment, soluble solids content and browning intensity are

Fig.2: Peeled fermented black garlic

Compounds formed during the fermentation

Compounds	Examples
Organo sulphur compound	SAC (S-Allyl Cystien)
Maillard reaction products	Heyn's, Amadori, 5-HMF (5-Hydroxy Methyl Furfural) and Melanoidin
Aroma compounds	DAS (Di allyl sulphide), DADS (Di allyl di sulphide), DATS (Di allyl tri sulphide).
Other compounds	Poly phenols, fructose, glucose

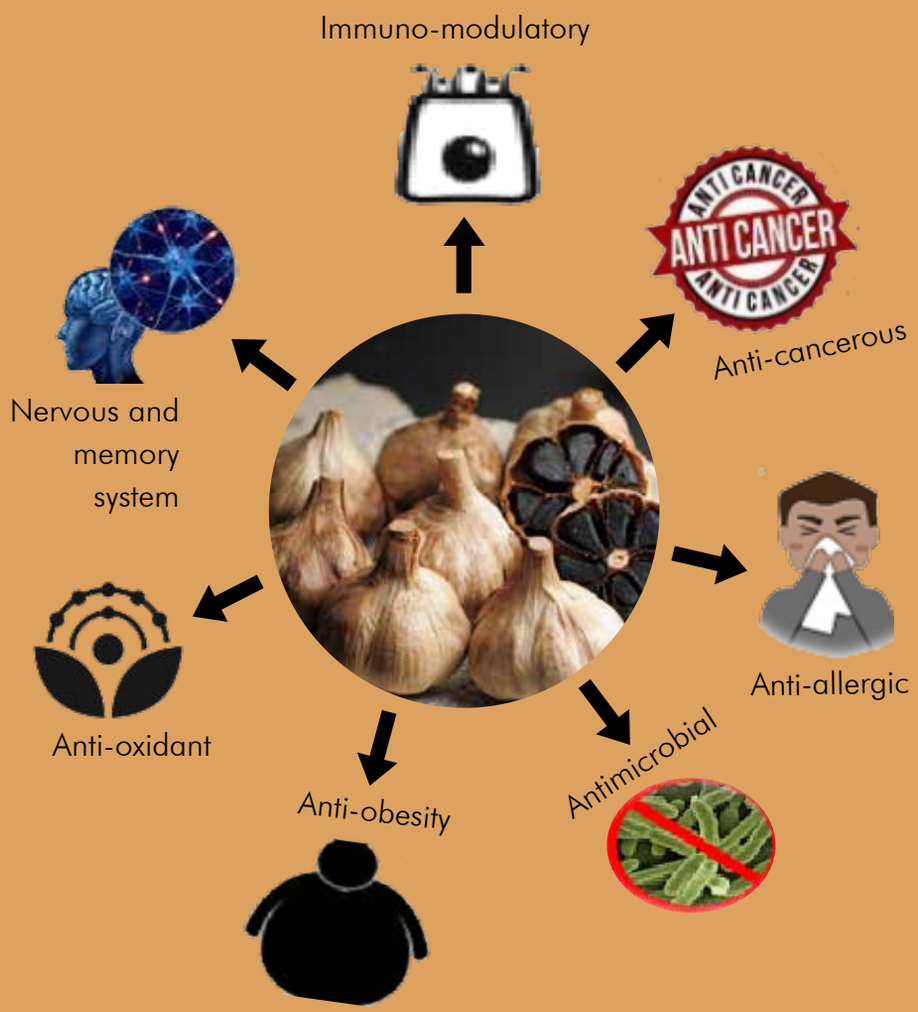


Fig.3

increased in garlic, whereas pH and water activity decreased. Sugar (e.g., glucose, fructose, sucrose, and maltose) contents increase in black garlic compared to fresh and steamed garlic. This increment might be related to its sweeter taste. pH significantly decreases during the manufacturing process. The pH in white garlic is the highest with a value of 6, whereas in black garlic pH decreases rapidly from 3.69 to 3.49 with aging. The water activity decreases with aging to a lesser extent than other parameters because the black garlic is produced by maintaining a high relative humidity. The color eventually changes to dark brown/black, mainly due to the formation of numerous compounds resulting from the non-enzymatic browning

reaction (Maillard reaction).

Health benefits of black garlic

During the fermentation period, unstable compounds in raw garlic are transformed into stable soluble compounds. It produces organo sulphur compounds, Maillard reaction products, aroma compounds and other compounds.

The production of these kind of magical compounds leads to various properties in black garlic like anti-oxidant, anti-obesity, anti-diabetic and anti-cancerous and it also influences the nervous and memory system, apart from improving the flavor.

Bioactivity of black garlic

The main bioactive properties of black garlic are shown in the figure 3.

Garlic has been a traditional medicine for various functional purposes (such as antibacterial, antidiabetic, anti-oxidant, anti-inflammatory, etc.) due to the presence of various organo-sulphur compounds. The production process of black garlic from fresh garlic brings about modifications in biological activities. The antioxidant activity of garlic is positively affected by the processing. Alliin and allicin are the unstable compounds present in fresh garlic, which are converted into a stable compound, SAC (S-allyl cysteine) in the presence of alliinase enzyme during the aging process. The aging process increases the number of desired polyphenols in black garlic which also increases the antioxidant potential. The DPPH free radical scavenging activity of black garlic is significantly higher than that of raw garlic. The optimum aging period for maximizing the antioxidant properties of black garlic is 21 days.

Fig.4: fermented peeled black garlic in bottles

Black garlic has antimicrobial activity against some common pathogens and was found effective against gram-negative Salmonella. Black garlic exhibited strong anti-tumor and anti-cancer action, and could inhibit the growth of many human cancer cell lines such as SCG- 7901 gastric cancer cell and HT29 colon cancer cell. The mechanism of anti-cancerous effect of black garlic involves tumor growth inhibition, stopping the cell cycle and induction of apoptosis. Researchers suggested that black garlic could be used as a dietary product for preventing and treating cancers. Black garlic has potential for anti-cancer ability by inducing caspase dependent apoptosis through both intrinsic and extrinsic pathways in human leukemic cells.

Obesity is an inducer of diseases such as type 2 diabetes, heart disease, liver disease etc. Black garlic produces anti-obesity activity by reducing the AST (Aspartate transaminase), ALT (Alanine transaminase) and LDL (Low density lipoprotein) level in the blood serum and also decreases the HDL (High density lipoprotein) in blood serum. So, it reduces the body weight, abdominal fat weight, abdominal fat pad thickness etc. Black garlic has been reported to have a better immunomodulatory effect than raw garlic. The immunomodulatory effect is through inhibition of the reactive oxygen species and mRNA expression of vascular cell adhesion molecule. The anti-allergic effect of black garlic is by reducing the release of b-hexosaminidase.

Among the processed products of garlic, black garlic is emerging as one of the most well- known functional foods in the market. Black garlic is used not only in the food industry, but also in the medical, cosmetic and beverage industries. It is available in different forms like powder, paste, peeled black garlic and whole black garlic. The products are available in the market at a price of rupees 500 to 3000 per kilogram. The Indian market for black garlic is still at a nascent stage. However potential awareness regarding its physiochemical properties, food applicability, and health benefits could boost the popularity of black garlic.

NANOTECHNOLOGY IN PEST MANAGEMENT

Devi Balakrishnan [1]
Ambily Paul[2]
[1]Ph.D. Scholar
Department of Agricultural Entomology
College of Agriculture, Vellayani,
Thiruvananthapuram
[2]Assistant Professor
Department of Agricultural Entomology
College of Agriculture, Vellayani,
Thiruvananthapuram

Introduction

Nanotechnology is a promising field of interdisciplinary research. It opens up a wide array of opportunities in various fields like medicine, pharmaceuticals, electronics and agriculture. These include insect pests management through the formulations of nanomaterials based pesticides, enhancement of agricultural productivity using bio conjugated nanoparticles (encapsulation) for slow release of nutrients and water, nanoparticle mediated gene or DNA transfer in plants for the development of insect pest resistant varieties and nanosensors for pesticide detection. Traditional strategies like integrated pest management used in agriculture are insufficient, and application of chemical pesticides have adverse effects on animals and human beings apart from the decline in soil fertility.2 Nanotechnology is working with the smallest possible particles which raise hopes for improving agricultural productivity through encountering problems unsolved

Table 1. Nano-base products in the market

Type of product	Nature of nanocontents	Manufacturer	Application
Karate® ZEON	Contains active compound	Syngenta	Broad control of Insect pests of cotton, rice, peanuts and soybeans
Cruiser MaXX	Insecticide with Fungicides (Thiamethoxam and Fludioxonil and Mefenoxam)	Syngenta	Extensive application in agriculture practices to protect seeds and seedlings
Subdue MAXX	Systemic fungicide	Syngenta	For the control of Pythium and Phytophthera blight

conventionally. Therefore, nanotechnology would provide green and efficient alternatives for the management of insect pests in agriculture without harming the nature.

Nanotechnology: Big things from a tiny world

Nanotechnology is Science of understanding and control of matter at dimensions of roughly 1–100 nm, where unique physical properties make novel applications possible. Nanoscale materials show unusual physical, chemical and biological properties, which are completely distinct from their bulk materials and individual molecules.

According to Bhattacharyya et al. (2010) the word "Nano" is developed from the Greek word meaning "dwarf". In more technical terms, the word "nano" means 10-9, or one billionth. Measurements between one and hundred nanometers are known as the nanoscale. Nanoparticles in agriculture serve as 'magic bullets' having insecticides, fungicides, herbicides, chemicals, or genes, which target particular parts of plants or organisms to release their content.Two principal factors cause the properties of nanomaterials to differ significantly from other materials are due to high surface area to volume ratio and small size. These two features will provide some unique properties to the NPs viz. Improved penetration solubility and stability, enhanced targeted activity, reduced eco-toxicity and electrical conductivity are some of the properties of NPs, which make them more reactive.

Nanotechnology: its applications in agriculture

With the growing limitation in arable land and water resources, the development of agriculture sector is only possible by increasing resources use efficiency with the minimum damage to agro ecology through effective use of modern technologies. Among these, nano technology has the potential to revolutionize agricultural systems, biomedicine, environmental engineering, safety and security, water resources, energy conversion, and numerous other areas. Nanotechnology is working with the smallest possible particles which raise hopes for improving agricultural productivity through encountering problems unsolved conventionally.

Some of the important application of nanotechnology in the field of agriculture includes: Nanofertilizers, Soil improvement, Water purification, Plant genetic modification, Precision farming and Nano Sensors.

Nanotechnology in pest management

Nanopesticides FAO estimates that annually up to 40 percent of global crop production is lost to pests. Each year, plant diseases cost the global economy over $220 billion, and invasive insects at least $70 billion (FAO, 2021). Conventional pesticide has got problem such as solvents and toxic ingredients directly leach and leak into the environment, pollutants in soil and water system, chemical residues in crops and food products, and potential threat to human health. The loss and decomposition rate of pesticide on crop foliage is very high, caused by run-off, spray drift and rolling down during field application. Developing new advanced nano-based formulations that remain stable and active in the spray condition (sun, heat, rain), penetrate and delivery to the target, prolong the effective duration and reduce

the run-off in environment one of the hotspots in the field of nano-technical agriculture applications.

Nanopesticides defines as any formulation that intentionally includes elements in the nm size range and/or claims novel properties associated with these small size range. Nano pesticides improves the solubility and dispersion in water, uniform leaf coverage, biological efficacy and environmental compatibility, due to the small particle size, high surface area and elimination of organic solvents in comparison to conventional formulation.

Nanopesticide development - approaches

I. Directly processing into nanoparticles

II. Loading pesticides with nano-carriers in delivery

I. Directly processing into nano particles

Nanoparticles attach to the insect cuticle resulting in cell lysis, it may bind with DNA or respiratory enzymes leading to the interruption in normal functioning of the insects and finally results in death.

A study has been conducted by Armugham et al. (2016) for finding out the effectiveness of nano silica particle on pulse beetle. SNP treated seeds of these three varieties of pulses revealed no effect on the growth of seeds as revealed by seed germination, growth rate of root and shoot and thus clearly demonstrated the useful nature of silica nanoparticles as seed protecting agent for the control of C. *Maculatus* in the experiments. A significant reduction in adult emergence was observed in all the treatments when compared to control. This study is the first effort in the utilization of nano-scale silica as protective agent or abrasive used to coat various seeds of pulses against infestation by stored product pests like C. *maculatus*. It was observed from the study that the physical characteristics of seeds play a significant role in limiting the coating or covering maximum surface area on the seeds by nanosilica.

II. Loading pesticides with nano-carriers in delivery systems

1. Nanoemulsion
2. Nanoencapsulation
3. Nanogel

1.Nanoemulsions

Nanoemulsions are oil-in-water (O/W) emulsions where the pesticides are dispersed as nano sized droplets in water, and the surfactant molecules localized at the pesticide-water interface. Nano emulsions improve the efficacy and safety effects of traditional pesticides, due to the small size effect, high dissolution rate and elimination of toxic organic solvent enhanced apparent -solubility and enhanced uptake/ efficacy. The study conducted by Nenaah (2014) suggests that the nanoemulsion may be useful to enhance water solubility of poor water soluble natural products with insecticidal activity. Essential oils of *Achillea biebersteinii*, *A. santolina* and *A. mellifolium* were obtained by hydrodistillation, showed considerable toxic and growth inhibitory activities against the red flour beetle, *T. castaneum (Coleoptera: Tenebrionidae)*. When prepared as nano-emulsions and tested as fumigants, toxicity of oils was increased dramatically.

According to Heyderi et al. (2019), Mean mortality percent of *Aphis gossypii* Glover adults after contact with different concentrations of *Mentha piperita* L. nanoemulsion in 24 hour increased with increase in the concentration of nanoemusion (about 90 per cent mortality in 4600 ppm as against 20 per cent in 3400ppm)

2.Nanoencapsulation:

Nanoencapsulation are core–shell structural vesicular systems, encapsulating the pesticide active ingredients in the inner core. The shell is usually composed of biodegradable polymeric, including polylactic acid (PLA), polyethylene glycol (PEG),chitosan etc. The polymeric shell degrades slowly in the environment, thus improves chemical stability for environment-sensitive compounds. In addition, nanocapsules can increase the targeting delivery efficiency with membranal polymeric leaf-affinity modification, improving the behaviours of wetting, spreading and absorbing of droplets on leaves. It will provide protection, increase solubility, reduce the contact of active ingredients with agricultural workers, reducing run-off rates.

3. Nanogel

Nanogel prepared from

pheremone methyl eugenol (ME) using low molecular masss gelation is a suitable remedy for extending shelf life and stability of ME.. This was very stable at open ambient conditions and slowed down the evaporation of pheromone. Such nanogels provide high pheromone retention capacity, enhanced shelf-life and protection of ME from environmental decompositions (from exposure to ambient air, water and sunshine). ME alone however, is quite volatile on its own and evaporates under ambient conditions significantly rapidly during the summer.

Green Nanotechnology

Green nanotechnology is the application of green chemistry and green engineering principles. Dr. Kattesh V. Katti is known as the father of green nanotechnology. It Means synthesis of nano particles from plant or microbes sources . Advantages of nanotechnology are (1)these are easily available and easy to handle (2) increase in toxicity, solubility and slow release of active ingredient. Neem, Geranium leaves, Catharanthus etc are some of the plants utilized for green nanotechnology. Hosamani et al. (2019) carried out the synthesis of silver green nanoparticles from soybean seed extract by sunlight exposure method and its influence on *S. litura*. The synthesized soybean based silver nanoparticles were characterized by UV- spectroscopy and particle size analyser. The result revealed that soybean based AgNo3 nanoparticles with a mean diameter of 87 nm possess high insecticidal activity. Increased concentration and exposure period enhanced larval mortality. AgNPs caused characteristic symptoms of sluggishness, inactiveness, the larvae refusing to feed resulting in larval mortality. Green silica nanoparticles synthesised from Paddy husk were tested at various doses from 250 to 2000ppm and compared with metal nanoparticles and an insecticide check against second and fifth instar larva of *S. litura* larvae. Observations were also recorded on pupal and adult deformity. The cent per cent mortality of second instar larva of *S. litura* larvae was observed by green and metal silica nanoparticle at 1500 ppm at five days after treatment. The dead bodies became extremely dehydrated and shrunken in

comparison with the live larva. Silica nanoparticles induced dehydration was the main reason behind their nanocidal property (Sushila et al., 2020).

Nanoparticles from micro organisms

Cell-free supernatant of *Photorhabdus luminiscens* (Thomas and Poiner) was converted to nanoparticles (NPs) using a spray dryer fitted with ultrasonic nozzle. NPs were characterized by both scanning electron microscopy and zeta size analyser, and found to have average particle diameter of 89 nm. While converting to NPs, gum arabica @ 3% was used to eliminate hygroscopic property. Nano particulated supernatant exhibited superior pesticidal property against serious sucking pests of cotton, viz. *Tetranychus macfarlanei* Baker and Pitchard and *A. gossypii*. High mortality coupled with quick action emphasizes the potential of nanotechnology in enhancing the pathogenicity of a microbial pesticide

Bionanomaterial: The efficacy of the DNA tagged gold nanoparticles on the major polyphagous pest, *S. litura* (Lepidoptera: Noctuidae) was evaluated to determine the efficacy of the test nanoparticle, dilutions viz. 200, 300, 400 and 500 ppm were prepared and 10 µl of the suspension was dispensed on the chickpea *(Cicer aritinum L.)* based semi-synthetic diet filled in 5 ml glass vials. Larval mortality data sets subjected to analysis of variance (ANOVA) revealed that the particles were effective and caused 50% larval mortality above 500 ppm. As the particle concentration and days after treatment increased, larval mortality also increased. The study demonstrated that DNA tagged gold nanoparticles are effective against *S. litura* and would therefore be a useful component of an integrated pest management strategy (Chakravarthy et al., 2012). Gold metal is a conductor of heat, but, when its size is reduced by one billion, it becomes insulator so that it can be used to deliver the toxicant to the target cells directly. It may suggest that DNA-tagged gold nanoparticles can affect phosphorylation in relation to kinase activity which helps to inhibit the indirect effect of DNA functions and thus lysis of the insect pest tissue leads to death of the *S. litura*. DNA-conjugated-gold nanoparticles have an effect on kinase activity.

Advantages of Nanotechnology over conventional pesticides

- Effective delivery of agrochemical -large surface area, easy attachment and fast mass transfer
- Increased target delivery efficiency of pesticide into action targets
- Reducing pesticides dose of application and treatment frequency by extended lasting validity period.
- Enhancing the bioefficacy, reducing the chemical input to plants, solving the problem of non-target toxicity
- Improves chemical stability for light sensitive compounds by restricting photodegradation
- Sustained release of pesticide protects biodiversity in ecosystem

Potential Risk of Nanopesticides

When considering all nanoproducts that will possibly emerge in the food and agriculture sectors, there is a widely accepted consensus that there is insufficient reliable data currently to allow a clear safety assessment. Exposure assessment relies on investigations into the environmental fate of a compound. There have been a limited number of studies investigating nano agrochemicals.

Overall, the current level of knowledge appears to be largely insufficient for a reliable assessment of the risks associated with the use of nano agrochemicals. A fair assessment of nano pesticides should, thus, be looking at evaluating both the risks and benefits associated with their use relative to current solutions.

Nanoparticles are expected to diffuse at a slower rate that is influenced by humic substances and mucoproteins. In addition, Nanoparticles may get entangled with mucoproteins, leading to prevention/ retardation of their uptake. Such processes at biological surfaces have the potential to alter the absorption and distribution of nano pesticides in comparison to traditional forms, with resultant effects on tissue distributions and biomagnifications potential.

Insect nanobots and cyborgs: Insect nanobots are insect mimicked robots with a natural ability to crawl through small spaces, offer unique advantages over traditional synthetic robots .This is widely used in scientific military field for gathering intelligence.

Insect cyborgs (Cybernetic Organism) are a combination of insect and machine manufactured due to technical limitations in constructing insect nanobots which helps in assisting humans in environmental sensing and rescue applications. The goal of the MEMS-microelectro mechanical system, inside the insects, will be to control the locomotion by obtaining motion trajectories either from GPS coordinates, or using RF, optical, ultrasonic signals based remote control. Olfactory training of bees has been used to locate mines and weapons of mass destruction and Detection environmental hazards to security surveillance are some of the applications.

Nanotechnology technology development in India

National Mission on Nanoscience and technology (Nano Mission) launched in 2007.

The other research centers of nano technology are:

I. Defence Research and Development Organization (DRDO)

II. Department of Atomic Energy (DAE)

III. Indian Council of Agriculture Research (ICAR)

IV. Indian Institute of Science (IISC)

Three major industrial associations involved in the promotion of nanotechnology in India

1) The Associated Chambers of Commerce & Industry of India (ASSOCHAM)

2) Federation of Indian Chambers of Commerce and Industry (FICCI).

3) The Confederation of Indian Industry (CII).

Conclusion

Agriculture in 21st century facing diverse challenges to produce more food and fibre to feed a growing population with a smaller rural labour force, changing climate and urbanization. These problems will further get intensify when we would have to feed over 9 billion population by 2050. To deal with this scenario, agriculture dependent countries have to adopt more efficient methodologies, labour saving and sustainable production methods. Nanotechnology with its phenomenal success have potential to facilitate and frame the next stage of precision farming and pest management techniques. It will increase agricultural potential to harvest higher yields in eco-friendly way even in challenging environment.

References

Armugham, G., Velayutham, V., Shanmugavel, S., and Janarthanan. 2016. Efficacy of nanostructured silica as a stored pulse protector against the infestation of bruchid beetle, Callosobruchus maculates (Coleoptera: Bruchidae). Appl. Nanosci. 6(3): 445– 456.

Bhattacharyya, A., Bhaumik, P. U., Rani, S., and Epidi, T.T. 2010. Nanoparticles - A recent approach to insect pest control. Afr. J. Biotechnol. 9(24): 3489-3493.

Chakravarthy, A. K., Bhattacharyya, A., Shashank, P. R., Epidi, T. T., and Mandal, S. K. DNA-tagged nano gold: a new tool for the control of the armyworm, Spodoptera litura Fab. (Lepidoptera: Noctuidae). Afr. J. Biotechnol. 11(38): 9295-9301.

FAO [Food and Agricultural Organization]. 2021. Annual Report 2020-21. Food and Agriculture Organization of the United Nations, Rome, Italy, 182p.

Hosamani, G.B., Patil, R. R., Benagi, V. I., Chandrashekhar, S. S. and Nandihali, B. S. 2019. Synthesis of green silver nanoparticles from soybean seed and its bioefficacy on Spodoptera litura (F). Int. J. Curr. Microbiol. App. Sci. 8(9): 610-618.

Heydari, M., Amirjani, A., Bagheri, M., Sharfian, I., and Sabahi, Q. 2019. Eco-friendly pesticide based on peppermint oil nanoemulsion: preparation, physicochemical properties, and its aphicidal activity against cotton aphid. Environ. Sci. Pollut. Res. Int. 27(6):6667-6679.

Nenaah, G. E. 2014. Chemical composition, toxicity and growth inhibitory activities of essential oils of three Achillea species and their nano-emulsions against Tribolium castaneum (Herbst). Ind. Crops and Prod. 53: 252-260.

[1]Shilpa S.,
[2]A. M. Nadaf,
[3]Chandan B. M.
[1]Ph.D. Scholar, Dept. of Entomology, UHS, Bagalkot
[2] Assistant Professor, Dept. of Entomology, UHS, Bagalkot
3 Assistant Horticulture Officer, Biocentre, Hulimavu, Bengaluru

Paracoccus marginatus

EMERGING INSECT PESTS IN INDIAN AGRICULTURE

The contribution of agriculture during the first two decades towards the gross domestic product ranged between 48 and 60 per cent and in India at least two-third of the working population earn their living through agricultural works. Due to excessive pressure of increasing population the growing countries like India are in rapid demand of food production. To achieve both food and nutritional security many challenges are in way such as instability due

Liriomyza trifolii

Thrips parvispinus

to varying monsoon conditions, inequality in land distribution among farmers, depletion and exhaustion of soils resulting in their low productivity due to careless use of manures, fertilizers and biocides, lack of knowledge about modern irrigation strategies combined with lack of mechanisation and continued use of simple and conventional tools and implements

Invasive and emerging insect pest in Indian agriculture

Apart from these elements one of the major challenges to humankind is threat to food security due to emerging and invasive insect pests. The agricultural economy in India is vulnerable to threat from invasive pests/diseases which act as the bottle neck in reducing yield. Invasive organisms are those that are exotic non-native, have high reproductive potential, and have few natural enemies and predators to check population growth and emerging pest is one whose status has been changing from minor to major or secondary to primary pest. The invasive pest species pose a substantial threat to biodiversity and to agriculture. Increased global trade in agriculture has increased the chances of the introduction of exotic pests. Papaya mealybug *(Paracoccus marginatus* Williams and Granara de Willink), cotton mealybug *Phenacoccus solenopsis* (Tinsley), coconut mite (*Aceria guerreronis* Keifer), serpentine leaf miner (*Liriomyza trifolii* Burgess) and tomato leaf miner *Tuta absoluta* (Meyrick) are among some examples.

Apart from the trade, climate change is one of the major causes of transboundary movement of insect pest. Example

Schistocerca gregaria

Spodoptera frugiperda

for which is a recent upsurge of dessert locust *Schistocerca gregaria* from Africa to other countries resulting in the crop loss. The current outbreak began when cyclone Mekunu in 2018 produced heavy rains in the Arabian Peninsula, in Spring 2019 the swarms spread from these areas, and by June 2019, the locusts spread north to Iran, Pakistan, and India and south to East Africa. The locust entered India much earlier during 2019 but large swarms were seen during May 2020 which entered through western Rajasthan and moved to the neighboring states like Gujrat, Maharashtra, Madhya Pradesh, Delhi and UP devouring lacks of hectares. The invasion area of desert locust covers about 30 million sq km which includes whole or parts of nearly 64 countries and in terms of monetory loss during 2019-20 about 100 crores have been lost (http://ppqs.gov.in/divisions/locust-control-research/locust-phases43).

Further the transboundary movement of fall armyworm *Spodoptera frugiperda* from America to India is a recent example of pest invasion due to climate change. Fall armyworm (FAW) is native to tropical and subtropical Americas and is known as a sporadic pest in the United States. In Latin America, FAW was observed to cause up to 73% yield loss in maize. Outside Americas FAW first invaded Africa, in 2016. In India, its presence was confirmed in May 2018 by the University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka. Since then, it has spread within the country and moved eastwards to countries bordering India. Hence, FAW with its remarkable dispersal ability and preference for warmer temperature has spread from its tropical and subtropical habitat of the Americas to India.

Rugose spiralling whitefly an invasive pest on coconut tree, is considered to be introduced from Florida (USA) into Tamil Nadu and Kerala during 2016. It has since spread to all coconut growing areas of the country.The pest attacks in severe proportion and its impact are higher on palms in terms of sooty mould deposits. The prolonged dry spell during June to September

and deficit rainfall coupled with decreased relative humidity seem to have favoured the spread of the pest in coconut plantations. The coconut growers would be able to get rid of the pests with application of one per cent starch solution on leaflets to flake out the sooty moulds. Installation of yellow sticky traps on the palm trunk as well as inter-spaces to trap adult whiteflies will also help.

Thrips parvispinus (Karny) is a cosmopolitan species of quarantine importance and has been reported from Thailand to Australia (Mound & Collins 2000). The last two decades witnessed a drastic extension in the geographic distribution of *T. parvispinus* and it is now known to occur in France, Greece, Hawaii, Mauritius, Reunion, Spain, Tanzania and Netherlands, besides India (Tyagi et al. 2015). In India, this species was first reported on *Carica papaya L.* (Caricaceae) in Bengaluru (Tyagiet al. 2015) and later on *Brugmansia sp.* (Solanaceae) and *Dahlia rosea* Cav. (Asteraceae) (Rachana et al. 2018; Roselin et al. 2021). It is a polyphagous pest, infesting beans, eggplant, papaya, pepper, potato, shallot and strawberry (NPPO 2019).Since 2015, this species has been collected from nine host plants belonging to seven families from five Indian states viz. Andhra Pradesh, Chhattisgarh, Karnataka, Kerala and Tamil Nadu. Out of nine recorded host plants, four were fruit crops, three were ornamentals, one each of vegetable and field crop, reflecting the adaptability of this thrips to feed and breed in diverse agro-ecosystems. The thrips cause large scale shedding of flowers, malformation of fruits and fruit drop in chillies, leading to severe yield loss. Subsequently, diagnostic field surveys were undertaken in the infested fields which revealed the incidence of thrips on flowers in alarming proportions. About 90 to 95 per cent flowers were badly damaged by the thrips, and on an average, 18.20 thrips were recorded per flower. Serious damage was recorded in Andhra Pradesh, Chhattisgarh and Karnataka on *Capsicum annuum*. In this context, establishment of *T. parvispinus* in different states of India demands a special attention as a major pest inflicting severe crop losses. Although not currently reported to be a vector of Tospo viruses, it may likely acquire viruliferous trait. Therefore, it is imperative that the domestic quarantine mechanisms are to be strengthened further to check the spread of this notorious pest to the rest of India.

Strategies to avoid spread of invasive thrips

- The main objective should be to evade further spread of this thrips to other chilli growing areas of India by complete destruction of the infested plants in the specific areas.
- Use healthy and pest free seedlings for planting.
- Constant exhaustive monitoring and inspection for its infestation in new areas through surveys in chilli growing areas.
- Microbial biopesticide based management practices-*Pseudomonas fluorescence*-NBAIR-PFDWD@20g/l or *Bacillus albus*-NBAIR-BATP@20g/l spray focusing on flowers and fruits.
- Use of neem oil, pongamia oil or soap solution in heavily infested sites.

Reference

Mound, L. A. & Collins, D.W. (2000). A South East Asian pest species newly recorded from Europe: Thripsparvispinus(Thysanoptera: Thripidae), its confused identity and potential quarantine significance. Journal of European Entomology, 97, 197–200.

Rachana, R.R., Roselin, P. &Varatharajan, R. (2018). Report of invasive thrips species, Thripsparvispinus(Karny) (Thripidae: Thysanoptera) on Dahlia rosea (Asteraceae) in Karnataka. Pest Management in Horticultural Ecosystems, 24(2), 187–188.

Roselin, P., Kuldeep Sharma. & Rachana, R.R. (2021). Diversity of floral thrips from Western Ghats of Karnataka. Indian Journal of Entomology, 83(3), 407–410.

AGRIVOLTAICS
A promising energy source?

Karthik R T
BSc (Hons) Ag graduate, College of Agriculture, Vellayani

Imagine that there is a way to double your income on the same piece of land. Doesn't it sound interesting? There are a few different ways to accomplish it, but agrivoltaics is a recent development in the field. In this technology, solar/photovoltaic panels are positioned at regular intervals throughout your fields so that, it assists in both growing the crop and capturing sunlight for energy enabling us to capture sunlight more efficiently.

Agrivoltaics or agriphotovoltaics, originally conceived by Adolf Goetzberger and Armin Zastrow in 1981, is the simultaneous use of areas for both solar power generation and agriculture. The system was first pioneered in Europe and Asia, the term agrivoltaics applied to dedicated dual use of technology, a system of mounts or cables to raise the solar panels some height, say 5m above the ground so that the land can be accessed by farm machinery, or as a system where the panels can be installed on greenhouse roofs. As the coexistence of solar panels and plants requires sharing of light between them, we have to compromise factors like optimising crop yield, crop quality and energy production. The shade produced by the array of panels can reduce the production of some crops, but such losses may be offset by the energy produced. Experiments are running worldwide to know about the efficiency of the system. The Fraunhofer Institute, an organisation promoting solar power, in 2021 claimed that all of Germany's energy needs could be met by covering 4% of the arable land with solar panels. The data from their website shows that this technology has developed very dynamically in

recent years, the installed power increased exponentially from approximately 5 MWp in 2012 to approximately 2.9 GWp in 2018 to more than 14 GWp in 2021 with national funding programmes in Japan, China France, USA and most recently Korea. (Wp= Peak Wattage)

There are a few methods for installing an agrivoltaic system, (i) the most conventional systems install fixed solar panels on greenhouses, above open fields or between field crops; the optimisation can be made by modifying the density of the solar panels or the inclination of the panels. (ii)Another system is a dynamic system, during the first stages the panels were mounted in thin pipes, which were easily dismountable and lightweight. The panels can be moved or adjusted manually during the seasons. (iii) A modification was brought by Günter Czaloun,who presented a photovoltaic tracking system with a rope rack system in which the orientation of the panels can be changed as needed to get the maximum solar power or to give shade to the crops. (iv) In 2015, Wen Liu from the University of Science and Technology in Hefei, China, proposed a new agrivoltaic concept with curved glass panels covered with a dichroitic polymer film that selectively transmits blue and red wavelengths which are necessary for photosynthesis. All the other wavelengths are reflected and used by the solar panels for power generation.

Data collected from the agrivoltaic farms shows that the air temperature and vapour pressure density were unaffected in the stilt mount agrivoltaic system, while the photovoltaic panels decreased soil temperature and affect the incoming solar flux distribution. Yields from the agrivoltaic systems were higher than the respective mono system yield when the LER methodology was used. The shading caused by the PV modules also helps in reducing water evaporation and is beneficial during the summer season. Due to the shading effect, the water savings were in the range of 14-29%, depending on the shade levels. Studies have shown that PV modules help to alleviate soil erosion by reducing moisture evaporation. Also being a power source, an agrivoltaic farm can help in powering irrigation and pumping water in electricity shortage areas. Although the shading effect has been considered an issue, shade-tolerant crops can be used to have a good level of production. Shade tolerant crops include hog peanut, alfalfa, yam, taro, cassava, sweet potato and lettuce.

Let us take a couple of studies in India, Let us start from Kerala itself, The Cochin

International Airport Ltd (CIAL) has achieved another milestone in sustainable development with the airport's agrivoltaic farming scaled up to 20 acres, the largest of its kind in the country. The water used to clean PV panels is used to irrigate the crops.The crops are expected to modify the micro-climates underneath PV modules by reducing the temperature, which results in increasing efficiency in power generation. Moreover, the crop coverage in between PV arrays will check the erosion of soil and thus reduce the dust load on the PV module. Another advantage is that the cultivation dampens the weed growth underneath the PV panel mounts. CIAL now has a total installed capacity of 40 MWp. Its PV plants produce 1.6 lakh units of power a day, whereas the daily consumption stands at 1.3 lakh units. CIAL's power plants are coupled with the Kerala State Electricity Board's power grid.

A study was conducted at ICAR-Central Arid Zone Research Institute, Jodhpur and it was observed that 49% land area of a solar PV installation system can be used to cultivate crops, which are otherwise left as fallow. The crops which can be grown in the interspace area between PV arrays are moong bean,moth bean, cluster bean etc. It has been found that 1400 litres of rainwater can be harvested per kW of agrivoltaic system, under similar circumstances. The stored water can be used for irrigation in the rabi season. As compared to the income from PV-generated electricity, income from the agricultural activity is quite less, but it has several environmental and societal benefits like: (i) it will judiciously use the scarce rainwater of arid regions, (ii) it will control soil erosion through wind action and thus reduce the dust load on PV modules, (iii) it will improve microclimate surrounding the PV module and thus helps in optimum generation of electricity from PV module, (iv) it will improve land equivalent ratio (LER) etc. The annual income from PV-generated electricity has been estimated as Rs 6000/- per kW installation, whereas the cost involved for installation of such a system is Rs 49,840/-, and thus, the breakeven period of the system is about 9–10 years. A study was modelled to assess the energy aspects and expected output per acre of farmland with the dual use of land in Nashik district of Maharashtra. Considering the shade tolerance of grapes, a techno-economic analysis is run for the installation of PV systems in the area available between the trellises on a grape farm. The electricity generation potential was determined per unit area and economic benefits for the cultivators were also quantified. The results show that using the agrivoltaic system model, the economic value of the farms may increase more than 15 times compared to conventional farming, while maintaining approximately the same grape production. The results show that if this dual use of land is implemented nationwide, it can make a significant impact by generating over 16,000 GWh of electricity, which has the potential of meeting the energy demands of more than 15 million people. These studies do not imply that they can be implemented throughout the country. Multi-location field trails and optimisation should be done according to the agroecological zones of India, so that this technology can be refined and efficiently used to increase the production of electricity as well as agricultural goods.

From this, we can evaluate the advantages of agrivoltaic systems which include, maximising productivity of food and energy combined; which could help in growing demands of energy while reducing fossil fuel consumption. They also reduce plant drought stress and reduce PV panel heat stress. Agrivoltaic systems have the competence to increase global land productivity by 35-73%. Also, agrivoltaic systems are now tried with emu, sheep, rabbits and even aquaponics. However, the identified barriers to adoption of agrivoltaics, include: (i) drop in production, (ii) market potential, (iii) limited to shade tolerant crops (iv) high initial costs and (v)high technical knowledge. If the above-mentioned demerits can be sorted out, they can be used to improve the technology and increase its adoption.

This system is an innovative and strategic approach to combining agricultural production with renewable energy.

This article just points out the advantages and disadvantages of the system, found by various researchers across the globe. Agrivoltaics might lead the way for green energy at the crucial time of transitioning to a more sustainable energy age.

DIVERSIFIED RANGE OF BEE HIVE PRODUCTS AND ITS USEFULNESS

Bees are most resourceful animals on the planet. Honeybees are best known bees, not only for the honey they produce, but also because they play very important role in pollinating various agricultural and horticultural crops. They are a component of our biodiversity on which we all rely for survival. They produces premier source of natural and high-quality food products. Honey, beeswax, venom, propolis, pollen, and royal jelly are all products of bees. Beeswax, venom, and royal jelly are chemically synthesised by bees, whereas other products are derived from plants and collected, modified and engineered by bees. While majority of these products can be consumed as raw product, but they also utilized as ingredients in synthesis of other products. The biochemical and economical value of various secondary products get increased by the quality and characteristics of bee products. Millions of honey bee colonies, mostly, *Apis mellifera*, are maintained all over the world. The world production of honey ranges between 15-16 lakh tonnes per year. In Asia, China is the leading country in

Sourabh Maheshwari[1]
Dr. Shakuntala Gupta[2]
[1]PG Research Scholar, Department of Entomology, G B Pant University of Agriculture & Technology, Pantnagar, Udham Singh Nagar, Uttarakhand
[2]Associate Director cum Office-in-charge, Krishi Vigyan Kendra, Nagina, Bijnor (SVBP University of Agriculture & Technology, Meerut, UP)

Honey Bee

Beeswax

Bee Venom

production and export of honey, beeswax, bee pollen and royal jelly. Honey and various other products of beehive are being increasingly recognised across the world as health foods. A diversified variety of beehive products are discussed as below:-

Honey

Honey is a light brown viscous liquid produced by honey bees. Honey is a mixture of sugars such as fructose (38.5%), glucose (31%), sucrose (1.3%) and maltose (7.1%). It is the primary saleable product from beekeeping with high commercial value. It has a long and illustrious history in human nutrition. Honey hunters have been raiding wild bee hives for thousands of years in search of valuable honey, a practise that is still prevalent today. Ancient civilizations all over the world have a history of hunting

Bee Pollen

beehives for the alluring honey and then later it is used in many traditional folk medicines. Today, it is a very popular stable sweetener and energy source. Honey is consumed either directly or used as a preservative for fruits and cakes. Raw honey contains immune-boosting and anticancer properties. In European countries, honey was mixed with wine or beer and fermented to produce a popular alcoholic beverage known as "Mead". Honey also posse's anti-inflammatory, anti-bacterial, anti-fungal, anti-viral, and anti-oxidant properties. In India, very small quantity of honey consumed and its per capita per year consumption is less than 50 g. Within Asia, Japan has the highest per capita consumption i.e. about 700 g. Average global per capita consumption is 250-300 g. There is still a need to raise public awareness

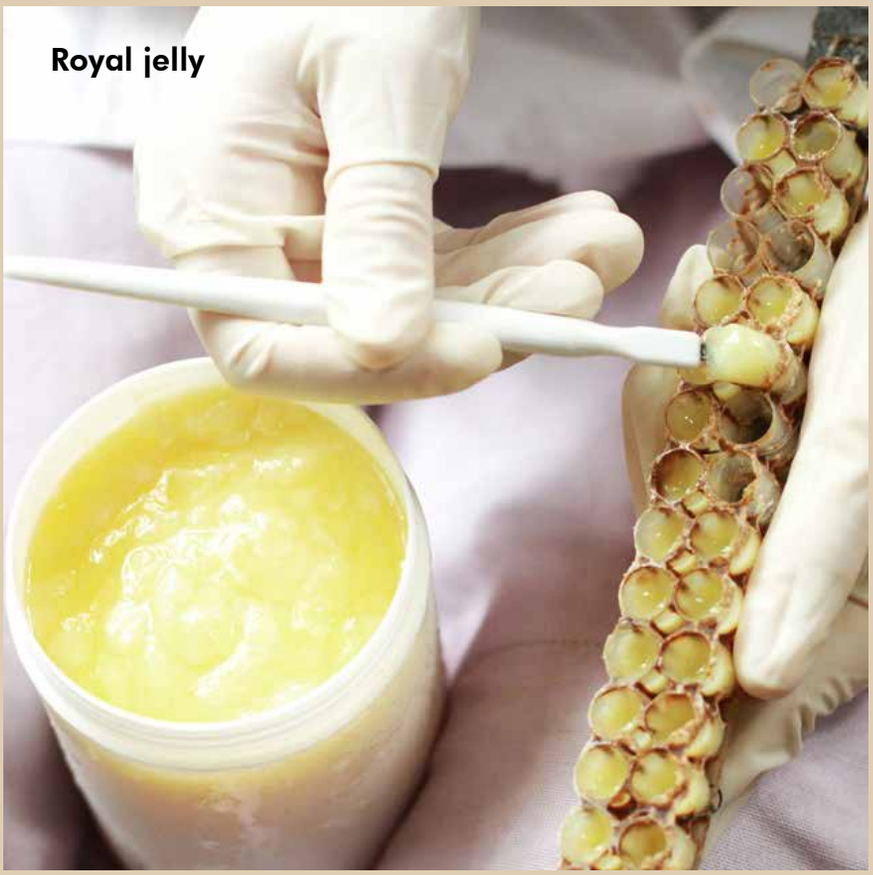
about the health benefits of such natural products and their daily consumption.

Pollen

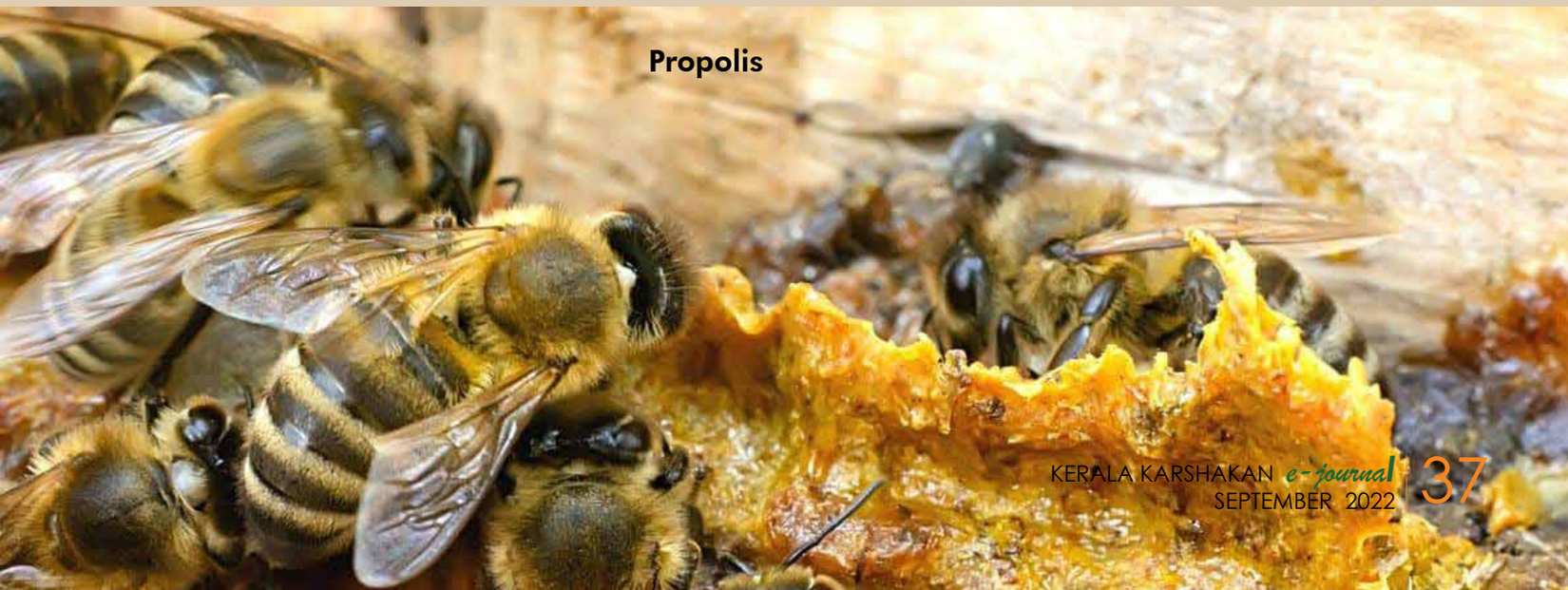
Pollen has been rated as a super food and its market growing rapidly worldwide. It is a nutrient-rich food like honey, and can be stored in the hive indefinitely to serve as a reserve during times or seasons of shortages. Pollen is a phenomenally nutritious and well-balanced food. Botanically Pollen grains are small, male reproduction units formed in the anthers of the higher flowering plants. The pollen is transferred onto the stigma of a flower (a process called pollination) by either wind, water or various animals (mostly insects), among which bees (almost 20,000 different species) are the most important ones. Pollen is prescribed in its dry pellet form as collected by the bees. Pollen is collected via specialized pollen traps fitted to beehives. It must be processed immediately after collection to avoid excessive moisture absorption and fermentation. Bee pollen is suggested for treatment of various prostate problems. It is also used as active ingredient in cosmetics, usually in the concentration of 0.5–5% to produce shampoos and conditioners. Daily ingestion of 15 gm of bee pollen is shown to be containing sufficient amount of required daily intake (RDI) for good health.

Propolis

Propolis is a high value beehive product. It is collected by bees from plants for sealing cracks and crevices in the hive. It is used by honeybees to varnish the interiors of comb cells/ beehives and for general purpose hive cleanliness. It is excellent anti-microbial agent towards bacteria, viruses, fungi, molds, and possesses a multitude of pharmacological properties. It is a mixture of beeswax and resins collected by the honey bees from plants, particularly from tree gums, glues, waxes and resins. The composition of propolis depends on the type of plants accessible to the



Royal jelly



Propolis

Bee bread

bees. Chemically, propolis is composed of more than 180 different types of chemicals. Major chemical compounds present in the bee propolis include, Flavonoids, Benzoic acid derivatives, Benzaldehyde derivatives, Carbohydrates, Vitamins (Vit. B1, B2, B6, C, & Vit. E), Nicotinic acid, various minerals and almost every essential amino acid. Propolis is used for healing wounds. It is a 'Natural Antibiotic' that strengthens health and immune system. For external use, propolis is processed and used in nose drops, cough syrup, tooth paste, lotions, salves, creams, skin oils, shampoo and skin soap. Health care products that contain propolis cure wounds, scars, infections, muscle ailments, eczema, psoriasis, warts etc. The market for propolis continues to grow, as it finds more acceptances in the pharmaceutical uses and cosmetic products.

Beeswax

Beeswax is a pliable, stable and moisture-proof material, used by bees to construct their nest. It is a malleable plastic material, with excellent moulding properties. It is a true wax and secreted as liquid, but solidifies when exposed to air. It is secreted by the four pairs of wax glands on the ventral side of the abdomen of worker bees of age 14-18 days in the hive. It is basically used to cap the ripened honey. It is mixed with some propolis to protect the brood from infections and desiccation. Together with propolis, wax is also used for sealing cracks and covering foreign objects in the hive. Pure beeswax consists of at least 284 different chemical compounds. Bee wax is utilized in candle making, waxing of some horticultural produce (eg. apples), crayons making, leather perseveration, polishes and varnishes. It is added to creams, salves, lotions, Lipstick and mascara. It is also used in ointments, liniments and creams in treatment of various several dermatological complexions, e.g., boils, wounds, atopic dermatitis, psoriasis etc.. Textiles and papers can be waterproofed with products containing

beeswax. Batik is a traditional method of colouring cloth also utilizes bee wax.

Bee Venom

Venom utilized by honeybees as defensive tool for stopping or deterring its predators. Venom is useful as it possesses a lot of pharmacological properties. Honey bee workers secrete bee venom from venom gland located in the abdominal cavity. Worker bees and the queen both have a sting at the end of their abdomen. The queen only uses this to lay eggs, but she can also sting with it. Worker bees do not lay eggs usually and use it as sting only. The sting is covered in barbs. Bee venom is a natural toxin that contains more than 18 different pharmacologically active compounds, which includes small peptides and enzymes that play a major role in defending bee. The extraction of bee venom is done by electric shock method. Bee venom has long been used in traditional medicine and has been considered a therapeutic modality in East Asia since the second century. Countries like China, Korea, and Japan have use bee venom either directly or via acupuncture-like bee sting or via a prepared injection to combat inflammatory problems. There are three forms of BVT- live bee sting, BV injection and BV acupuncture (BVA). The live bee sting belongs to traditional BVT which is most commonly used. It is applied by inserting live bee sting directly into the patients' skin. It is currently used in wound healing, to treat back pain, skin diseases, and rheumatism. It is also used as a remedy for many ailments ranging from multiple sclerosis, arthritis, and asthma to malaria and epilepsy.

Royal jelly

Royal jelly belongs to a group of products which are described as "dietary supplements". It has a variety of moisturizing, emulsifying and stabilizing properties that makes it very useful. Actually, it is a white and viscous jelly-like substance which is secreted by the hypopharyngeal glands of young worker (nurse) bees. This jelly like substance is used to feed the developing young larvae and the adult queen bee. It is directly provided to the queen and larvae with its secretion and is never stored inside the colony. Largest use of royal jelly is in cosmetics. It is mostly used for skin refreshing and skin regeneration or rejuvenation purpose. It is also used in creams or ointments for healing burns and other wounds. It is also recommended for stomach, liver and digestion problems, high blood pressure, loss of appetite, weight loss, fatigue, listlessness, insomnia, pregnancy, menopause, old-age problems, convalescence and athletics. Royal jelly can be viewed as a tonic to feel stronger, healthier and less tired.

Bee bread

Bees make bee bread out of the pollen that they have collected. Bees push these loads with their heads into the honeycomb cells, and press them into pellets with a small amount of honey and saliva. This undergoes biochemical processes caused by enzymes added through the bees' saliva and stomach fluids. Bee bread contains fewer proteins than the original pollen, but they are easier to absorb. It contains the substances like proteins with essential amino acids, vitamins C, B1, B2, E, H (biotin), K, P (rutin), nicotonic acid, folic acid and pantothenic acid, pigments, carotenoids and anthocyanins. It contain enzymes like saccharase, amylase and phosphatise etc. More than 25 different minerals and spore elements such as iron, calcium, magnesium, phosphorus, potassium, copper, zinc and selenium are present in bee bread.

The combination such biologically active substances make bee bread effective for the prevention and treatment of various diseases. Vitamin content in bee bread improves the metabolism and the functioning of the nervous system and it stimulates the production of red blood cells (RBC) and the haemoglobin count of children as well as adults. The use of bee bread is recommended for anaemia, hepatitis, diabetes and in gastrointestinal problems such as colitis, constipation and diarrhoea. Bee bread reduces cholesterol, improves the lipid pattern and cleanses the blood; it also improves gall bladder and liver functions and reduces blood pressure.

Conclusion

These unique products make honey bees as most resourceful creature. With increased awareness of the beneficial aspects of these hive products, the use and demand products is increasing. Bee hive products are specially utilized for synthesis of number of secondary products.

JUTE STICK ACTIVATED CARBON (NINFET-JAC)

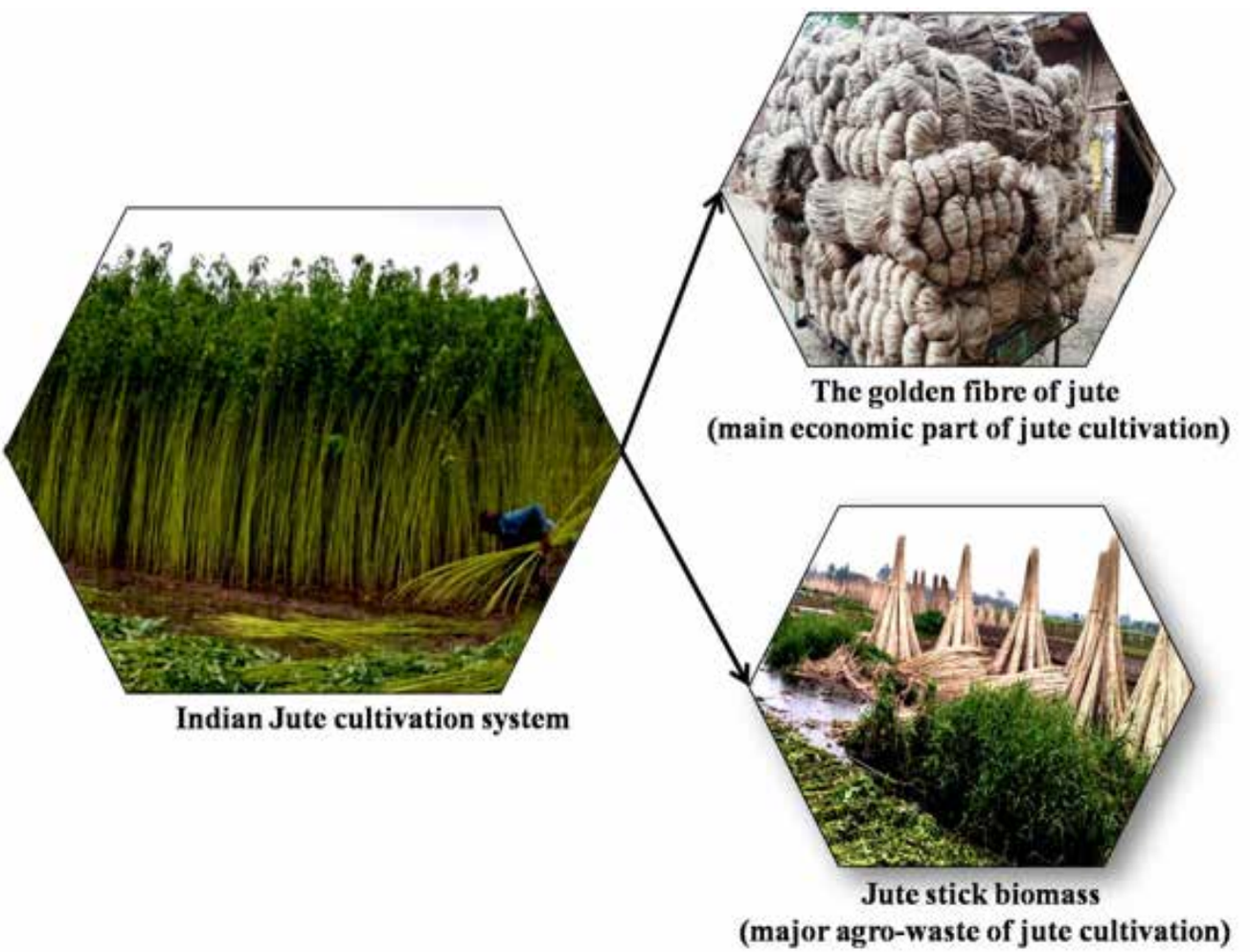
An indigenous clean-up material for pesticide residue analysis from agro

Rakesh Kumar Ghosh[1*]
Deb Prasad Ray[1]
Kaushik Banerjee[2]
Sambhunath Chattopadhyay[1]
D B Shakyawar[1]
[1]ICAR-National Institute of Natural Fibre and Engineering Technology, 12 Regent Park, Kolkata, 700040, West Bengal, India; 2National Reference Laboratory, ICAR-National Research Centre for Grapes, P.O. Manjri Farm, Pune, 412307, India

Plant protection chemicals, introduced to secure/protect food and feed for humans and animals from pests, have become a concern for consumers' health safety due to pesticide residues in food and other commodities (FAO/WHO, 2019). Under the tropical-humid climatic condition of the Indian subcontinent, the crop production, as well as the post-harvest processing system, is prone to pest attacks, and crop loss may go up to 35-40 and 30% during crop production and post-harvest storage, respectively, worth around INR 14 lakh corers. During the early 1960s, around 25, 18, 10, and 10% of fruits, cotton, rice, and sugarcane, respectively, were lost due to pest infestation. However, the crop loss scenario has changed since 2000, and

loss in cotton production (30-50% loss) is followed by rice (20%), vegetables and fruits (13-24%), coarse grains and oilseeds (6-7%) and sugarcane (2-3%). Hence, application of plant protection chemicals to secure food and feed for a developing country like India has become an unavoidable practice. An increase in crop loss during post-green revolution time was observed as compared to the pre-green revolution phase even after the application of pesticides which could be due to combined effects of change in cropping pattern, development of resistance in pests, an outbreak of secondary pest, climate change, etc.

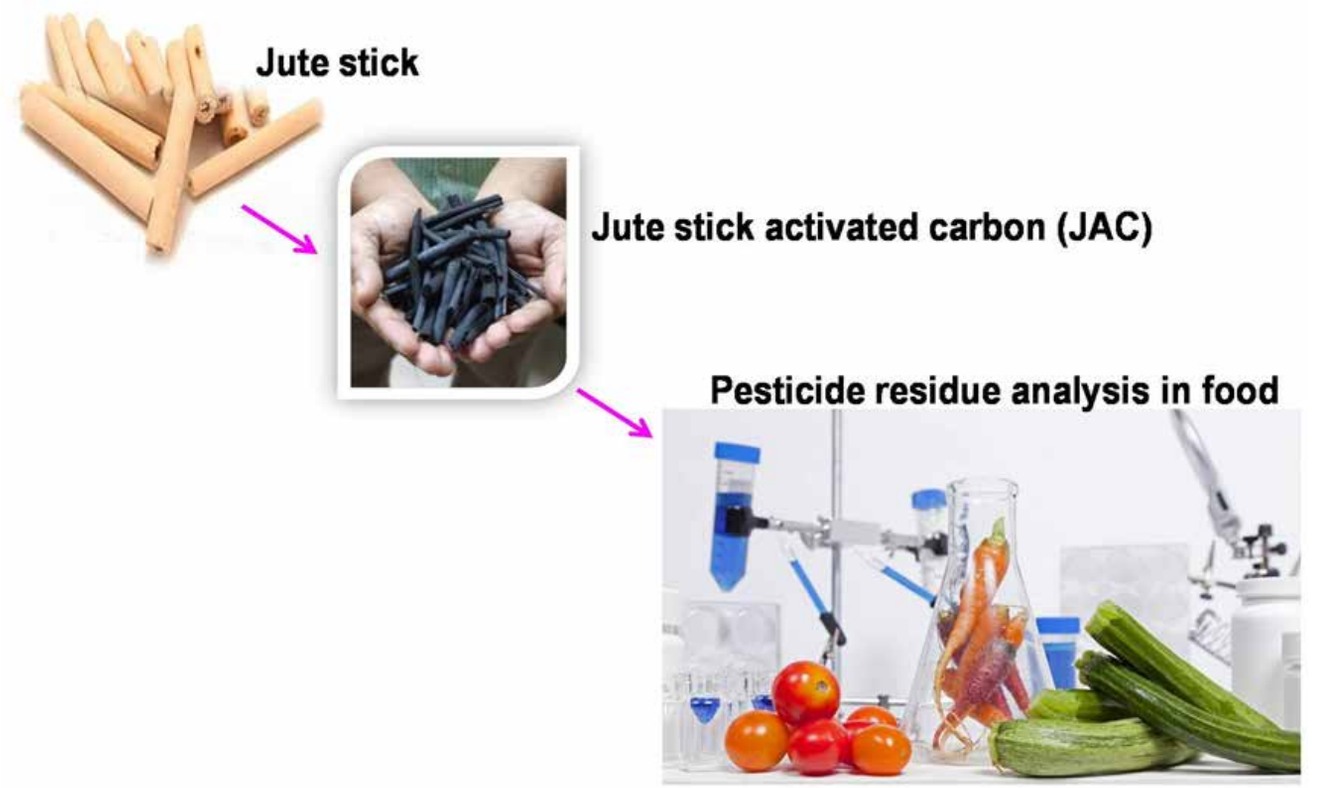
Hence, the application of pesticides to ensure food security has increased over the past few decades. The annual consumption of pesticides in India had increased from 39773 tonnes in 2005-06 to 52980 tonnes in 2011-12, though the total production of pesticides was stagnant at 80,000 tonnes since 2005-06. Though pesticide consumption (0.5 kg per ha) in India was much lower (only 3.57% of global production) than in other developed countries like the USA (4.5 kg/ha), Korea (6. Kg/ha), and Japan (12 kg/ha), environmental contamination with pesticide residues have become a severe issue. In India, the agro-horticultural production system (consuming ~ 67% of total pesticides consumed) and the public health sector (accounting for ~8.5% of total pesticides consumed) act as the direct and indirect sources of pesticide contamination. Malpractices in crop protection, for example, 15 numbers of pesticide sprays instead over a recommended 8 numbers of spray in rice growing areas of Raichur and Bellary, Karnataka; 20-30 numbers of spray over recommended 15 sprays in cotton belts of



Guntur and Warangal, Andhra-Pradesh; 15-20 numbers of spray over a recommended 10 numbers of spray for cole-crops in Nasik, Maharastra, etc., have increased the pesticide load in the environment. Indiscriminate and uncontrolled applications of pesticides have resulted in pesticide residues in various environmental components invading almost every food chain. Therefore, determination of pesticide residues in crops/ commodities has become mandatory for consumers' safety (FASSI 2016). Pesticide residue analysis involves the mandatory sample preparation involving sample clean-up, followed by an instrumental analysis of the processed sample.

The most commonly used clean-up material is graphitized carbon black (GCB), a costly (nearly INR 20000-22000 per 25 g) material derived from non-renewable sources, and is mostly imported. Though GCB suffers from the disadvantages of low recovery of planer pesticides, the non-availability of any low-cost alternative material has made GCB a dominant clean-up material for sample preparation during pesticide residue analysis in food and other products across the world. Hence, apart from other fixed input costs including instruments, manpower, etc., and replacement of GCB with a low-cost indigenous product holds immense potential to reduce the cost of sample analysis which in another way will promote a large number of sample analysis for consumers' safety at both national and international level. Hence, the quest for a low-cost clean-up material has always been a point of the researchers to make food analysis cheaper.

The Indian subcontinent is blessed with various natural fibres like cotton, jute, mesta, sisal, linseed, banana, pineapple, etc., and jute, the bast fibre, holds the second important position after cotton. Jute *(Corchorus olitorius)* is popularly cultivated for its 'golden fibre' and it is well known in packaging applications like sacking, hessian, etc. over the past 150 years owing to its high tensile properties and biodegradability. Further, recent applications in biocomposite, paper, geotextiles, agro-textiles, lifestyle products, etc. have created new market opportunities for jute fibre. The Indian subcontinent is the major producer and supplier of raw jute and jute-derived products to the entire world. India exported



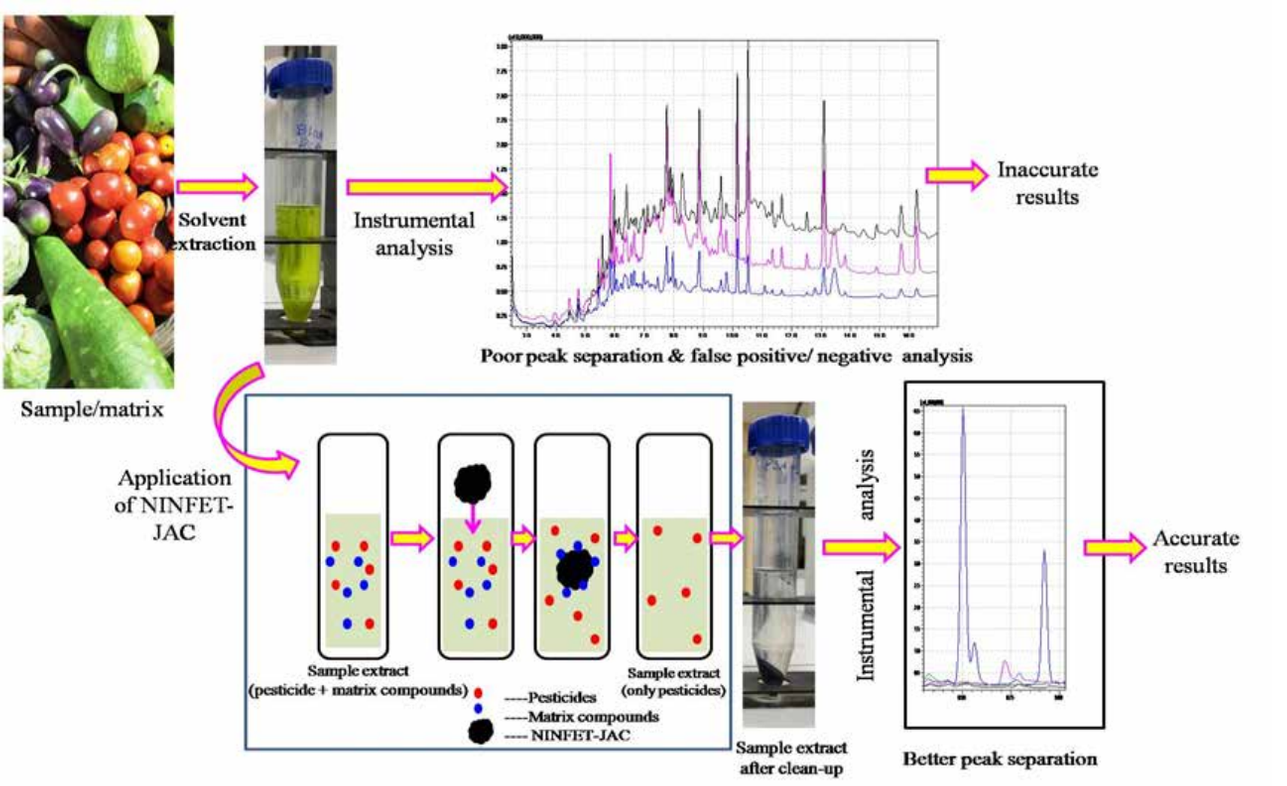


Figure 1. Schematic diagram representing clean-up activities by NINFET-JAC

around 1,28,680 MT of jute and jute products with a value of US$ 325 Million during 2018-19. The Indian jute industry supports 4 million farm families, and nearly 0.37 million direct and indirect workers and their families. Hence, the Indian jute sector plays a significant role in the national as well as the global economy. In jute cultivation, the stick is the major by-product of jute, and approximately 4 MT of sticks per annum is generated in India. Jute cultivation, for fibre purposes, takes only 4–5 months and generates such a huge quantity of lignocellulosic sticks (cellulose ~41%, lignin ~24%, hemicellulose ~30%) which is composition-wise comparable to woods grown over several years. The lingo-cellulosic jute stick is neither suitable for mulching nor as fodder, nor thus commonly used as a fuel source in rural households. Hence, utilisation of jute sticks as new raw material for activated carbon production will not only control pollution due to on-site/offsite burning of jute sticks but also help the existing carbon industry to overcome the challenges of deforestation. The global activated carbon market was valued at USD 2.96 Billion in 2020 and is projected to grow at a CAGR of 3.5% from 2020 onwards.

Activated carbon generated from jute stick biomass was reported as an adsorbent to remove various pollutants like heavy metals, synthetic textile dyes, etc. (Ghosh et al., 2020, 2021). However, the application of jute stick activated carbon as a clean-up material in pesticide residue was completely unknown. Till recently, a product named NINFET-JAC, a low surface area activated carbon developed from jute stick was found efficient as a clean-up material and comparative in terms of performance like GCB during the analysis of 181 pesticide residues in commercially important crops like okra (*Abelmoschus esculentus*), spinach (*Spinacia oleracea L.*), pomegranate (*Punica granatum L.*) and tea (*Camellia sinensis L.*), and may be suitable for other food materials (Ghosh et al., 2021

and Indian Patent Application No. 202131009421).

During pesticide residue analysis, the sample is extracted by an organic solvent that contains naturally occurring matrix compounds and pesticide residues, if present in the sample. The uncleaned sample extract may give erroneous readings due to coelution of matrix compounds along with the target pesticide molecules. The result could be false positive or false negative peaks for pesticide residue, which may create a hue and cry situation. Therefore, sample clean-up is a mandatory process to remove the co-eluting matrix compounds from the solvent extract before injecting them into the instrument. The porous NINFET-JAC acts as a selective sieve to remove matrix compounds like pigments, fatty acids, polyphenols, etc. from the solvent extract of the samples and leaves the pesticide molecules in the solvent extract (Figure 1). Hence, the interference of matrix compounds during instrumental analysis gets reduced and generates better and more accurate results about the pesticide residues in the sample.

Clean-up with NINFET-JAC (5mg/ml sample extract) was superior to GCB in terms of pesticide recovery with low matrix interference. Addition of GCB or NINFET-JAC along with PSA (primary secondary amine) to the solvent extract resulted in reduction of residues to 16.3-20% for GCB, and 40-46.7% for NINFET-JAC by gravimetric analysis, and pesticide recoveries were in the range of: 63.2-120% and 69-127.5% in okra, 62-117.9% and 60.4-117% in pomegranate, 68.6-126.8% and 61-114.6% in spinach and 69.3-117.4% and 59.8-113.9% in tea for NINFET-JAC and GCB, respectively. Unlike the petroleum-based GCB (costing approximately 11-12 USD per gram), NINFET-JAC could be generated from a low-cost agro-residue of jute stick with a tentative production cost of USD 10 per kg (i.e USD 0.01 per gram). Our estimates showed that NINFET-JAC would be 1100-1200 times cheaper than GCB. Therefore, NINFET-JAC could reduce the food testing cost, which will directly boost a large number of testing of food products.

Hence, JAC holds immense potential as a new indigenous product under the banner of 'Make in India'' and may help the Indian food testing laboratories to perform food analysis at a lower cost, leading towards the 'Atmanirbhar Bharat'.

References

- Ghosh, R.K., Ray, D. P., Chakraborty, S., Saha, B., Manna, K., Tewari, A., & Sarkar, S. (2020). Cadmium removal from aqueous medium by jute stick activated carbon using response surface methodology: factor optimisation, equilibrium, and regeneration. International Journal of Environmental Analytical Chemistry, 1–18. DOI:10.1080/03067319.2019.1700964.
- Ghosh, R.K., Ray, D.P., Tewari, A. & Das I (2021) Removal of textile dyes from water by jute stick activated carbon: process optimization and isotherm studies. International Journal of Environmental Science and Technology. https://doi.org/10.1007/s13762-020-03003-5
- Ghosh R.K., Majumder S., Bhattacharyya A., Paul A., Khan Z., Ray D.P., Chattopadhyay S.N., Pardesh A., Shakyawar D.B., & Banerjee K. (2021) Introducing a low-cost jute activated carbon as a novel cleanup agent in multiclass pesticide residue analysis using gas chromatography tandem mass spectrometry, Journal of Cleaner Production, 319: 128696, https://doi.org/10.1016/j.jclepro.2021.128696
- "Development and Application of Lignocellulosic Biomass Carbon as a New Clean-Up Agent in Pesticide Residue Analysis of Food Materials" by Ghosh, R.K., Ray, D.P., Chattopadhyay, S.N., Pan, N.C. & Banerjee, K. Patent Application no.: 202131009421 dated 06.03.2021.

C. Pradeepika
SenthilSankar C.
Visalakshi Chandra T.
Krishnakumar
M.S. Sajeev
ICAR-CTCRI, Sreekariyam,
Thiruvananthapuram, Kerala, 695017

Probiotic Rich Frozen Yogurt

FOCUS ON COLORED SWEET POTATOES BASED-FROZEN YOGURT

Curd or Dahi(the resultant of milk curdling with few drops of sour curd)is a healthy delicacy in tropical countries like India among all walks of life particularly during summer times to cool down the body's heat. On other hand yogurt prepared by specific known bacterial fermentation (*Lactobacillus bulgaris, Streptococcus thermophilus,* and *Bifidobacteria*) of milk. Consumption of curd and yogurt on regular basis promotes good gut health, boosts immune system, lowers blood pressure, and strengthens the bone & joints. A consumer survey (2021) revealed yogurt as indulgent, nutritious and affordable

Frozen yogurt brands available in the indian market

Frozen yogurt brands available in the international market

snack food highly prepared during COVID-19 outbreak. In consequence yogurt brands are innovating/introducing frozen desserts like 'frozen yogurt' to attract health-conscious consumers who are motivated to indulge in healthy snacking. In addition, International Frozen Yogurt Association (IFYA, 2017) consumer survey respondents (95 %) showed strong interest towards 'I enjoy eating frozen desert' statement in the questionary whereas only 5% respondents did not agree. Moreover, in terms of nutrition frozen yogurt preferred as a healthier alternative to ice cream due to its probiotic related gut health benefits, good amounts of fiber due to addition of fruits/vegetables, calcium, magnesium and relatively lowers fat and sugars. In addition, frozen yogurt gathers both rich and creamy nature of the ice cream as well as additional functional properties of yogurt. The primary difference is frozen yogurt made with fermented milk product or yogurt fortified with natural fruits (Mango, banana, blueberry, raspberry, strawberry etc.) and vegetables (colored sweet potatoes rich in bioactive compounds etc.) (Ranadheera et al., 2012). Whereas, ice cream is made up of milk solids and cream. Both contain sweetening agents, emulsifiers and stabilizers in common. Presence of good amounts of probiotic organisms and relatively lower fat and sugar'frozen yogurt' is becoming popular among frozen dessert lovers. According to a consumer survey (2021), 50% of consumers are motivated buy healthier snack foods which contributes to their overall health. In this context, the global frozen yogurt market size is expected to increase from a value of USD 1.69 to 2.14 billion at a CAGR of 3.5 % during 2021 to 2025 (Fortune Business Insights, 2019). Similarly in India flavored and frozen yogurt market is project to grow at CAGR of 21.3 % during 2021 to 2026 (IMARC, 2020). The main driving force for rapid growth in frozen yogurt market is increasing awareness among consumers particularly health-conscious young generation who are constantly looking for a healthy and nutritious diet (Market Research Reports, 2019). Hence frozen yogurt business segment marketed it as healthier alternative as it provides essential nutrients coupled with probiotic bacteria linked human gut health benefits (Chandan, 2015). Frozen yogurt comes in many daring and varied flavors than ice creams, which includes taro, guava, lychee, blackjack cherry, orange fleshed sweet potato, purple fleshed sweet potato, cake batter, cookie dough, red bean paste etc. According to International Frozen Yogurt Association (IFYA, 2019) frozen yogurt flavors not stayed same over the years, they are evolving with unique flavors and toppings. Current trends in Asian frozen yogurt market sector includes fresh honeycomb soft serve, Taiyaki (Japanese fish shaped pancakes)filled with soft serve frozen yogurt, Black Sakura (prepared with naturally activated charcoal and Saukura blossom infusion). Moreover, frozen yogurt-based beverages such as yogurt-based smoothies and slushy drinks, frozen yogurt milkshakes etc.with added toppings are becoming popular among youth who are ready to pay a premium for healthier foods (IFYA, 2019). As mentioned earlier, frozen yogurt or frozen yogurt based-beverages fortification with natural fruit or vegetable base provides excellent sources of dietary nutrients such as dietary fiber, natural sugars, minerals,

and micronutrients coupled with probiotic bacteria in the final product. This article focuses on sweet potato based frozen yogurt and its antioxidant linkedhuman health benefits.

Among starchy tuber crops, sweet potatoes are excellent sources of health protecting/ promoting phytochemicals such as beta carotene and anthocyanins along with dietary fiber, vitamins (pro-vitamin A), and minerals like potassium that help to fight several non-communicable diseases (Kusano and Abe, 2000). Moreover, sweet potato is a versatile vegetable and makes a great number of dishes which are enjoyed during festive times like thanksgiving in almost 17 different countries and as a fasting food in India. Among different flesh-colored sweet potatoes, orange fleshed tubers are well known for their richness of beta-carotene (pro-vitamin A) and purple fleshed tubers are for anthocyanin. Previous studies have shown that these nutraceutical compounds can offer various pharmacological properties such as anticancer (Wu et al., 2015), anti-inflammatory (Kang et al., 2014), antioxidant and antidiabetic (Jawi and Budiasa, 2011).Hence, nutritional intervention utilizing colored sweet potatoes in preparation of frozen yogurt may offer benefits such as nutritional, functional, and textural improvement of the product and associated development in human gut microbiome (Mehta et al. 2021). In this context, Liu et al. (2020) investigated the impact of sweet potato dietary fiber on gut microbiota and suggested sweet potatoes an excellent prebiotic food which helps in growth of many beneficial bacteria thriving in human colon. Similarly, Muchiri and McCartney (2017) demonstrated orange flesh sweet potato puree showing good prebiotic potential to modulate beneficial bacterial (*Bifidobacterium* genus) growth and activity associated with stimulation of short chain fatty acids like butyric acid (favorable for human gut health). Lestari et al. (2020) reported purple fleshed sweet potato-based yogurt as a potential functional food owing to reduced LDL cholesterol levels in a rat model. Chintha et al. (2021) studied *Lactiplantibacillus plantarum* based biotransformation strategy using three different flesh-colored sweet potatoes (off-white, orange, and purple fleshed). Results showed improved retention, stability, and bioavailability of phenolic bioactive compounds with enhanced antioxidant, antidiabetic, antihypertensive properties. Moreover, extensive literature is available on sweet potato based fermented foods such as sweet potato-based yogurt & curd, shochu (Japanese distilled liquor), Lacto-pickles, Lacto-juice, wine, and beer (Ray and Sivakumar, 2009). However, a limited number of studies reported about colored sweet potato based frozen yogurt development. Hussein and Aumara(2006) reported sweet potato based frozen yogurtas functional food with nutritional, functional, and good organoleptic scores. In addition, higher viable cell counts of *Streptococcus thermophilus*, and *Bifidobacteria*(probiotic starter) was observed until eight weeks of storage (Hussein and Aumara, 2006).Likewise, Dewi et al. (2015) reported addition of 1-3 % sweet potato starch to the frozen yogurt showed positive effect on growth and activity of Lactic acid bacteria as well as production of EPS (exopolysaccharides). Further addition of sweet potato starch acted as cryoprotectant, which helps inminimization of loss of cell viability of Lactic acid bacteria during prolonged freezing conditions.

In conclusion, development of frozen yogurt using sweet potato tuber rich in oligosaccharides,natural nutraceutical compounds such as beta-carotene (pro-vitamin-A from orange sweet potato) and anthocyanin (from purple sweet potato) with antioxidant, antidiabetic, and anti-cancerous, antihypertensive efficacy has greater potential to offer cost-effective dietary solutions to protect from non-communicable diseases. Moreover, developing sweet potato based-probiotic rich frozen yogurt could not only address the public health challenges but also contribute to the global food security by promoting demand for production of different flesh-colored sweet potatoes.

Reference

1. Chandan, R.C., 2015. Health benefits of yogurt. Health Benefits of Fermented Foods and Beverages, pp12, 275.
2. Chintha, P., Sarkar, D., Pecota, K., Dogramaci, M. and Shetty, K., 2021. Improving phenolic bioactive-linked functional qualities of sweet potatoes using beneficial lactic acid bacteria-based biotransformation strategy. Horticulturae, 7(10), p.367.

The triumphant journey of a vernacular farm magazine

KERALA KARSHAKAN

The premiere farm magazine in Malayalam entered 64th year of publishing

Subscribe - Rs 100/- Annual
Rs 1000/- Lifetime

For details : editorkkfib@gmail.com

MO/DD Send to Principal Information Officer,
Farm Information Bureau,
Kawdiar PO,
Thiruvananthapuram, Kerala
Phone - 0471- 2314358 / 2318186
Mail: editorejournalkkfib@gmail.com
Log on to http://www.fibkerala.gov.in

Published by **Suraj S** Principal Information Officer Farm Information Bureau Owned by Department of Agriculture, Government of Kerala and Published at Farm Information Bureau, Kowdiar P.O, Thiruvananthapuram-3. Editor: **Sreekala S.** Mail: editorejournalkkfib@gmail.com Log on to http://www.fibkerala.gov.in Phone: 0471-2314358