ONLINE ISSN 2583-4339
www.journalworlds.com

Agri JOURNAL WORLD

Volume 4 issue 2 February 2024 Pages 63

PUBLISHED BY LEAVES AND DEW PUBLICATION

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

Published By

LEAVES AND DEW PUBLICATION
B- 132, Nanhey Park,
Uttam Nagar, New Delhi 110059

Agri JOURNAL WORLD

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

CONTENTS

APICAL ROOTED CUTTING: A UNIQUE METHOD OF POTATO SEED PRODUCTION

Kumari Anjani

Department of Agricultural Biotechnology and Molecular Biology, College of Basic Sciences and Humanities, Dr Rajendra Prasad Central Agricultural University, Pusa

Corresponding author email: anjanikumari1234@gmail.com

ABSTRACT

Potato cultivation plays a crucial role in sustaining India's rice-wheat cropping system amid climate change, ensuring farmers' income. However, the success of this strategy hinges on the availability of quality seed potatoes, a significant production cost. Conventional seed production methods fall short of meeting the demand for high-yield, disease-free seeds. Hi-tech alternatives like tissue culture and aeroponics, while effective, are prohibitively expensive. Addressing the need for an affordable solution, the Apical Rooted Cutting (ARC) seed production technology integrates benefits from conventional and hi-tech methods. This cost-effective approach facilitates the rapid production of superior, disease-free seed potatoes, presenting a viable solution to the country's prevailing seed scarcity issue.

INTRODUCTION

Potato is a very important crop, which can play a vital role in enhancing food security. Due to its high nutritional value and ability to produce considerable amount of dry matter, potato can also address the problem of “hidden hunger” (the issue of micronutrient deficiency) (Lal et al., 2023), thus enhancing nutritional security. It is thus aptly referred to as ‘king of vegetables’ and regarded as exceptional crop by the Food and Agriculture Organization (FAO) (Devaux et al., 2019). The potato can also play a major role in maintaining the sustainability of the rice-based cropping system, which is facing major alternations and threat in the current regime of climate change. Being a high yielding and labour-intensive crop, potato can help to maintain farmers income in the current scenario, particularly in a country like India which has surplus labour and limited capital (Pandey et al., 2016; Singh et al., 2016). But, the profitability of the potato-based cropping system depends upon the availability of quality seeds. Since potato is propagated through seed tubers, a good potato seed should be free from diseases and have high productivity. In India the cost of these type of seed is high and accounts for 40-50 percent of the total production. This limits the profitability of the potato-based cropping system and is the key deterrent for the small farmers to take up potato production.

CONVENTIONAL SEED PRODUCTION SYSTEM AND ITS LIMITATIONS

The leader in seed potato production in India is ICAR-CPRI and other agencies, which produce potato by conventional "seed plot technique" (Pandey et al., 2012). The potato production by this technique involves vegetative propagation of tuber with simultaneous indexing against all major viruses and subsequent clonal multiplication in four cycles for breeder seed production (Sadawarti et al., 2017; Singh et al., 2019). This technically demanding method has many limitations like low rate of multiplication, limitation in development of 100% healthy seed stock from infected material, progressive accumulation of degenerative viral diseases and several field multiplications of initial disease-free material. This makes the seed production programme labour intensive, time consuming and expensive; resulting in less adaptability (Chiipanthenga et al., 2012). Moreover, this system of seed production is prone to diseases and infestation which build up after several generations of seed propagation (Sadawarti et al., 2017). Also, the local cultivars are not prevalent in this seed production chain. As a result, only a limited organisations and large landholding farmers take up this daunting task of potato seed production, creating a huge scarcity of the seed potatoes in the country (VanderZaag et al., 2021). Therefore, there is an urgent need to revive the Potato sector through developing alternate decentralized seed production system which ensures good quality seeds at affordable prices to farmers (Singh et al., 2023). To alleviate this problem, hi-tech method of potato seed production involving tissue culture, aeroponics and others can be used. The farmers, particularly small holding farmers, can also be involved in participatory seed production chain to increase the seed production. But the major challenges in realising this task is the availability of a low-cost method for production of seed potatoes. Apical Rooted Cutting (ARC) based seed production systems can solve this problem. This technology is adequate for low-cost production of disease and virus free potato planting material (Vander Zaag and Escobar, 1990).

PRINCIPLE OF APICAL ROOTED CUTTING TECHNOLOGY

An apical rooted cutting (ARC) is a rooted transplant produced from tissue culture plants referred to as mother plants. The principle behind the technique is that the mother plant, which has simple rounded juvenile leaves, are capable of producing apical cutting which can develop roots. The mother plant can be used to produce ARC as long as it is in juvenile state and does not reach physiological maturity characterized by development of compound leaves, vascularization and tuberization (VanderZaag et al., 2021). The juvenility of the mother plant can be maintained for long time in controlled conditions and it can produce ARCs for many generations. The ARCs can be transplanted in the field/greenhouses, where they produce mini tubers/tubers which are disease and virus free and equivalent to Nucleus seed (G0).

The ARCs can be supplied to seed companies for tuber seed production or they can be supplied to the farmers as planting material for seed production or potato cultivation.

PROCEDURE OF APICAL ROOTED CUTTING TECHNOLOGY-BASED POTATO SEED PRODUCTION SYSTEM

The rooted apical cuttings-based seed production systems involve two major stages:

1. Production of apical rooted cuttings in a lab and greenhouse:

The purpose of using ARC based system for seed production is to produce disease-free planting material (Buckseth et al., 2019). So, to begin with, the pure cultures of potato are produced through *in vitro* methods. The clonal propagation of these cultures is done for mass multiplication of the disease-free plantlets (Fig. 1 A). These micro plants are then transferred to seedling trays having substrate mixture for acclimatization and hardening, to produce mother plant (Fig. 1 B). The mother plants are grown in controlled conditions (in controlled polyhouse or greenhouse) to maintain their juvenility. The apical portions (1.5-2.0 cm) of 10-15 days old mother plant are cut and planted in substrate mixture for the development of roots (Fig. 1 C-E). The mother plant is left to grow further and develop secondary branches. The cuttings are again made from 7-10 days old branches of the mother plant. The process can be repeated 5-6 times or till the juvenility of the mother plant is maintained. The apical cuttings planted in the substrate mixture develop roots after 10-15 days. The cuttings are allowed to grow for 15-20 days in controlled polyhouse or greenhouse. These rooted cuttings (Fig. 1 E) can then be transplanted in fields or net house for development of tubers/minitubers (Fig. 1 F-J).

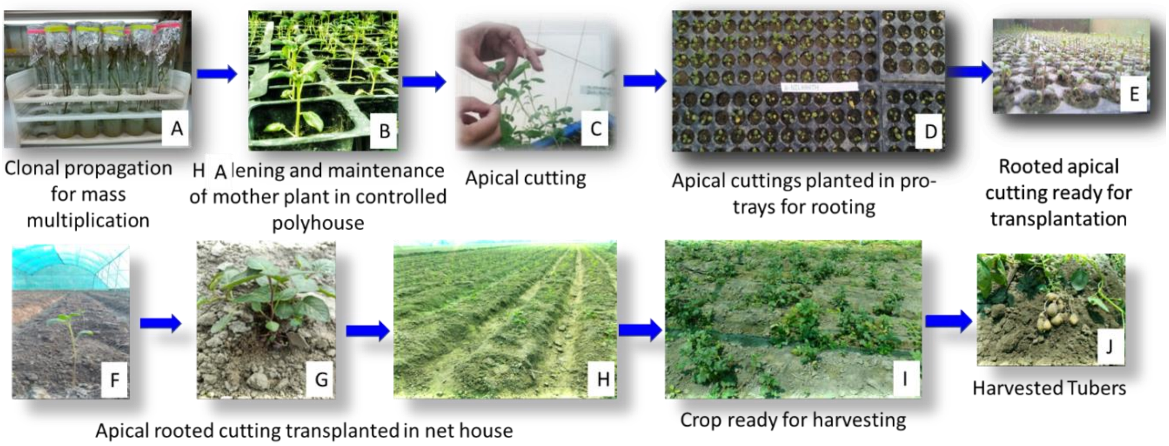


Fig. 1 Schematic Representation of Apical rooted cutting system

2. Distribution of ARCs to farmers and stakeholders for seed production:

The rooted apical cuttings developed in control conditions, act as seed and can be supplied to farmers or stakeholders. These cuttings are disease free and have high tuberization ability. Thus, they can be used by farmers either for seed production or potato tuber production. The first-generation tubers produced by this method is equivalent to nucleus seed (G0). These G0 seeds can be used as seed for production of tubers in controlled net house, which are equivalent to pre-breeder seed (G1). The G1 seed can be planted in open field to produce breeder seed (G2). The further multiplication of these seeds in open fields for three generation can lead to production of certified seeds. Hence, the farmers can use the ARC based system to produce certified seed in less time (Anjani et al., 2023).

ADVANTAGES OF ARC BASED SYSTEM OVER CONVENTIONAL SEED PRODUCTION SYSTEM

The ARC based system of potato seed production is a very unique system, which has the ability to revolutionize the potato seed production system in India, by enabling the smallholder farmers to participate in seed production. This is possible due to the many advantages of ARC based system over conventional seed production system. In the conventional system, the major challenge is the production of disease-free seed tubers. Since the rooted apical cuttings act as planting material for ARC based seed production systems and these cuttings are produced from tissue culture plants, they are free from any diseases or viruses. The input required for producing disease free seeds is thus minimal.

The second major challenge of the conventional system is low productivity and high cost. An apical rooted cutting has high productivity and has the ability to produce 10-25 or more seed tubers as compared to 5-10 seed tubers per minitubers. Also, one mother plant can be used to produce many ARCs as long as the juvenility is maintained. One microplant can produce six to eight rooted cuttings (Buckseth et al., 2022). Thus, the rate of multiplication is high in ARC based system and cost per plant is less, making it more economical. The cost-effective nature of this system also helps to introduce exotic, local landraces in the seed production chain (VanderZaag et al., 2021).

The third major challenge of conventional system is the time required to produce certified seeds. The tubers produced from apical cuttings can directly act as nucleus seeds. These can be multiplied using traditional cultivation methods to produce certified seeds in the fields. Thus, the time required to produce certified seeds is 4-5 years as opposed to 9-10 years in conventional method. The ARC based seed production technology thus combines the benefits of conventional as well hi-tech potato seed production system in addition to decreasing the cost and time, enabling small farmers to take up seed production (Buckseth et al., 2022).

CONCLUSION

Apical root cutting's have all the benefits of an *in vitro* produced plants but the cost per plant is less. Also due to their high tuberization ability, the apical root cutting based systems have become more economical. Thus, due to the high productivity of rooted apical cuttings, less time required to produce disease free and superior quality seed tubers, high rate of multiplication and less cost; the apical root cutting based system becomes economical for multipliers to sell quality seed and enables small farmers to participate in the potato seed production.

REFERENCES

Anjani, K., Jha B.K., Suman, S. K., Tigga, A., Kumar C. and Jha, R.K. (2023) Standardization of Apical Rooted Cuttings (ARCs) based technology for low-cost and rapid production of quality seed potatoes in Bihar. Souvenir, proceedings cum Abstract Book in three days 6th International Conference entitled "Strategies and Challenges in Agricultural and Life Science for Food Security and Sustainable Environment (SCALFE-2023)" during April 28-30, 2023 at Himachal Pradesh University, Summer Hill, Shimla, HP, India. ISBN No.: 978-93-91872-31-1 Page: 169.

Buckseth, T., Singh, R. K., Challam, C., Tiwari, J. K., Sharma, A. K., & Chakrabarti, S. K. (2019). Apical root cutting: A novel technique for the production of quality seed potato. Indian Horticulture, 64(6).

Buckseth, T., Tiwari, J. K., Singh, R. K., Kumar, V., Sharma, A. K., Dalamu, D., ... & Pandey, N. K. (2022). Advances in innovative seed potato production systems in India. Frontiers in Agronomy, 4, 956667.

Chiipanthenga, M., Maliro, M., Demo, P., & Njoloma, J. (2012). Potential of aeroponics system in the production of quality potato (Solanum tuberosum L.) seed in developing countries. African Journal of Biotechnology, 11(17), 3993-3999.

Devaux, A., Goffart, J. P., Petsakos, A., Kromann, P., Gatto, M., Okello, J., ... & Hareau, G. (2020). Global food security, contributions from sustainable potato agri-food systems. The potato crop: Its agricultural, nutritional and social contribution to humankind, 3-35.

Lal, P., Tiwari, R. K., Behera, B., Yadav, M. R., Sharma, E., Altaf, M. A., ... & Kumar, R. (2023). Exploring potato seed research: a bibliometric approach towards sustainable food security. Frontiers in Sustainable Food Systems, 7, 1229272.

Pandey, N. K., Singh, D. K., Singh, B. P., Jeevalatha, A., Raigond, B., & Singh, B. (2016). ADVANCES IN QUALITY POTATO PRODUCTION AND POST-HARVDST MANAGDMDNT.

Pandey, N.K., D.K. Singh, K.K. Pandey, Sanjeev Sharma and B.P. Singh. (2012) Agro -Techniques for Production of Quality Potato Seed, CPRI Extension Bulletin No. 43, Central Potato Research Institute, Shimla, Himachal Pradesh, India, pp. 14

Sadawarti, M. J., Pandey, K. K., Singh, S. P., & Singh, Y. P. (2017). A review on Comparison of Tissue Culture v/s Conventional System of Seed Potato Production.

Singh, R. K., Dubey, S. K., Singh, R. K., Buckseth, T., & Singh, A. K. (2016). Farmer participatory seed potato production through Krishi Vigyan Kendra Networking: An action research for enhanced availability of seed potatoes in India. Potato Journal, 43(2).

Singh, H. P., Singh, B., and Kumar, R. (2023). Approaches to sustaining potato production in India, technical bulletin 2023, Confederation of Horticulture Associations of India, New Delhi.

Singh, R.K., Buckseth, T., Jagesh, K. Tiwari, Ashwani, K. Sharma, Singh, V., Kumar, D., E.P. Venkatasalam, Raj, K. Singh, Sadawarti, M.J., Challam, C., and Chakrabarti, S.K. (2019). Seed potato (Solanum tuberosum L.) production systems in India: A chronological outlook. Indian Journal of Agricultural Sciences 89(4): 578-87.

Vander Zaag, P., & Escobar, V. (1990). Rapid multiplication of potatoes in the warm tropics: rooting and establishment of cuttings. Potato research, 33, 13-21.

VanderZaag, P., Pham, T. X., Demonteverde, V. E., Kiswa, C., Parker, M., Nyawade, S., ... & Barekye, A. (2021). Apical rooted cuttings revolutionize seed potato production by smallholder farmers in the tropics. Solanum tuberosum-A Promising Crop for Starvation Problem, 1-19.

How to Cite:

Kumari, A. (2024). Apical rooted cutting: A unique method of potato seed production. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):1-6.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

ELECTROSPUN NANOFIBERS: NEW GENERATION MATERIALS FOR PESTICIDE DELIVERY AND DETECTION

Riya Kundu, Neethu Narayanan, V. S. Rana, N. A Shakil and Parshant Kaushik*

Division of Agricultural Chemicals, ICAR-Indian Agricultural Research Institute, New Delhi-110012

*Corresponding author email: parshantagrico@gmail.com

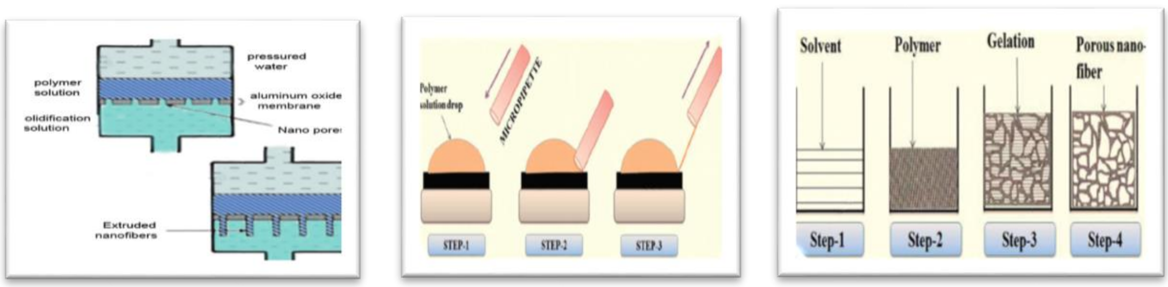
ABSTRACT

Electrospinning, or E-spin, is a unique technique generating nanofibers from polymers and metal oxides through a needle propelled by a peristaltic pump and high-power supply. Electrostatic interactions result in fiber formation, with applications spanning filtration, tissue engineering, wound healing, and energy storage. Electrospun nanofibers function as cost-effective electrocatalysts for simultaneous oxygen and hydrogen generation. In agriculture, they facilitate smart pesticide delivery and rapid detection. A novel nano/micro-structured pesticide detection card, integrating electrospinning and hydrophilic modification, enhances pesticide detection and broadens applications. Eco-friendly electrospinning of cellulose diacetate nanofibers on seeds addresses environmental concerns, exemplifying the versatility of this method in developing effective pesticide delivery systems and detection devices.

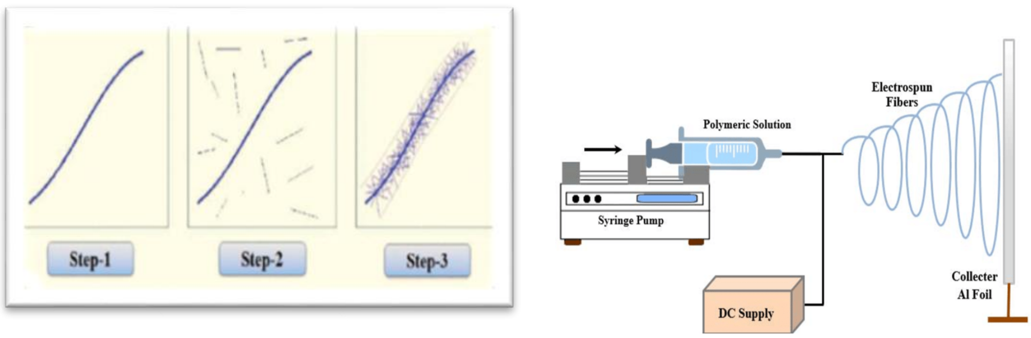
INTRODUCTION

Nanotechnology is highly integrated with our society and will have a greater impact in the coming decades as compared to other technologies. It involves manipulating matter at the atomic scale, where a nanometer represents one billionth of a meter (10^{-9}). By combining the prefix "nano" and "technology," it encompasses the study of tools, machines, and techniques used to understand and control materials at the nanoscale. Essentially, nanotechnology involves the exploration and application of knowledge at the atomic and molecular levels to address challenges and perform specific functions. Nanotechnology finds diverse applications across agriculture, sensors, manufacturing, medicine, defence, electronics and energy. In the agricultural sector, it is employed in development of biosensors, nano pesticides, antimicrobial nanoparticles, agricultural diagnostics, quality control of products and the exploration of plant physiology.

Various methods are available for synthesis of nanofibers (Fig. 1), including template synthesis, phase separation, self-assembly and electrospinning. In template synthesis, a metal oxide template with nanoscale-diameter pores undergoes water pressure application on one side, leading to the extrusion of polymer through a porous membrane. Upon contact with a solidifying solution, nanofibers are formed. Drawing involves introducing a micropipette to a polymer droplet, and pulling a single-strand nanofiber is formed. Phase separation entails preparing a homogeneous polymer solution that tends to separate into polymer-rich and polymer-lean phases, forming a matrix and pores, respectively, after gelation. Self-assembly arranges small molecules concentrically, allowing bond formation and extension in the plain normal to give the longitudinal axis of the nanofiber. Electrospinning, the simplest and most cost-effective method, involves spinning polymeric solutions or melts in a high DC electric field at elevated temperatures, producing high-surface-area submicron and nanosized fibers with exceptional physical properties. These fibers, known as electrospun nanofibers, are obtained from the majority of synthetic and naturally occurring polymers dissolved in suitable solvents.



(A) Template synthesis (B) Drawing (C) Phase separation



(D) Self –assembly (E) Electrospinning

Fig. 1: Different methods for synthesis of nanofibers

HISTORICAL BACKGROUND OF ELECTROSPINNING TECHNIQUE

The electrospray technique, which originated in the late 1890s, underwent a transformation into electrospinning around the year 1900. To provide a detailed historical overview of this innovative method, a comprehensive timeline of electrospinning development is presented in Table 1. It is noteworthy that research publications post-2010 predominantly focus on the applications of electrospun fibers in various fields, leveraging functionalized polymers, fibers incorporating nanoparticles, and composite nanofibers with metal oxides.

Table 1: Timeline of electrospinning development

S. No.	Year	Nature of advancement
1	1900,1902	Cooley and Moeton patented the process of E-spin
2	1914	Jet ejection at the tip of the metal capillary by John Zeleny
3	1934	Formhals patented the invention of E-spin instruement
4	1936	Patent for air- blast fibers formation from melt rather than solution by Norton
5	1938,1940	Others patents by Formhals
6	1950-1959	Factory production of nanofibers as filter for gas mask application
7	1960	Jet formation study and E- spin fibers as filtration material
8	1964	Formation of Taylor cone
9	1971	Apparatus to spin acrylic micrfibers by Baumgarten
10	1995	Doshi Reneker reported the fibers diameter decrease with increase in distance from collector to needle tip and Taylor cone
11	1996-2001	Publication related to working parameters such as, solution, ambient and instruemental parameters
12	2001-2005	Synthesis and characterisation of E- spin nanofibers
13	2006- till date	During these period most of the papers were put forward on the applications of E-spun nanofibers as sensors, tissue engineering materials, protection against chemical warfare stimulants, filters, scaffolds, batteries and catalyst

WORKING, INSTRUMENTATION AND OPERATIONAL PARAMETERS

WORKING:

The fundamental principle underlying fiber-forming technology is rooted in the "electrostatic attraction" of charges. In this process, a syringe contains a polymer solution with its inherent surface tension, and the solution is charged externally by applying high voltage from a power supply at the needle tip. A collector with opposite charges is positioned at a distance (around 10 cm) to gather the discharged fibers. When subjected to high voltage (10–30 kV), the solution within the syringe is ejected, overcoming surface tension and forming a cone-shaped structure known as a "Taylor cone" where drops are ejected from the tip. The jet extends under the influence of the electrical field, allowing solvent evaporation, resulting in the formation of solidified polymer fibers forming an interconnected web on the collector.

INSTRUMENTATION

The E-spin instrument comprises three main components: the primary influencer is the high voltage power supply, followed by the syringe and needle assembly (collectively known as the spinneret in the needleless type), and the collector. They are categorized based on orientation into horizontal and vertical types (Fig.2). In the horizontal configuration, the effective force involves the charged force generated by applied voltage and the opposite attractive force in the collector, which pulls the fibers. Conversely, in the vertical configuration, two forces draw the fibers – the collector charge and the gravitational pull – resulting in narrower fibers with a minimum diameter. Depending on the number of nozzles, such as single nozzle E-spin, easily soluble solutions can be spun into fibers. Multi-nozzle configurations offer an advantage over single nozzles due to increased fiber production. Based on the nature and number of axial units, such as mono-axial, co-axial, and multi-axial E-spin, monoaxial types have only one syringe and needle, co-axial types involve two syringes and a single needle, with solutions of different polymers/precursors that are likely immiscible.

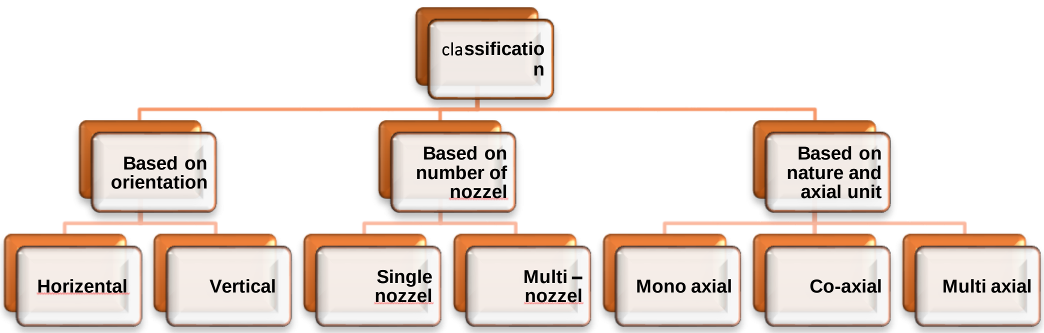


Fig.2: Different types of E-spin instruments

OPERATIONAL PARAMETERS

Solution parameters encompass factors such as concentration, molecular weight, viscosity, surface tension and conductivity/surface charge density. Processing parameters involve applied voltage, feed rate/flow rate, type of collector and tip-to-collector distance. Ambient parameters include humidity and temperature (Fig. 3).

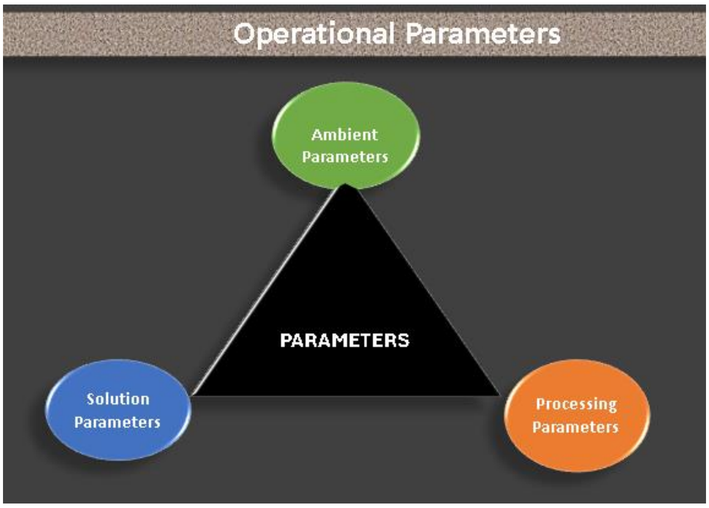


Fig. 3: Different operational parameters for E-spinning

CHARACTERISATION OF ELECTROSPUN NANOFIBERS

Characterizing electrospun fibers poses a considerable challenge due to the rarity of obtaining single fibers. The characterization of these fibers falls into two main categories: physical and chemical. Physical characterization focuses on the structure, morphology, and internal nanofiber structure, which collectively determine the physical and mechanical properties. Geometrical characterization involves parameters like diameter and size distribution, orientation, as well as morphology, encompassing surface roughness and cross-section. Key techniques for classifying fiber structure and morphology include scanning electron microscopy (SEM), transmission electron microscopy (TEM), field emission scanning electron microscopy (FESEM), and atomic force microscopy (AFM). SEM is primarily employed to determine fiber diameter and morphology but requires a conductive sample. However, SEM faces limitations in resolution at extreme magnifications. In contrast, TEM is effective for determining the diameters of extremely small fibers (less than 300 nm). AFM is another useful technique for detecting fiber diameter and providing a detailed examination of morphology and surface characteristics. Additional techniques, such as X-ray diffraction (wide-angle (WAXS) and small-angle (SAXS)) and differential scanning calorimetry (DSC), are considered to assess the degree of crystallinity in the fibers. Surface chemistry is further elucidated using X-ray photoelectron spectroscopy (XPS) and attenuated total reflectance Fourier-transform infrared spectroscopy (ATR-FTIR). While this chapter primarily focuses on the physical characterization of electrospun fibers, surface chemical properties can also be explored through molecular structure characterization using Fourier transform infrared (FTIR) and nuclear magnetic resonance (NMR).

APPLICATION OF ELECTROSPUN NANOFIBERS

E-spun nanofibers are characterised with large surface area to volume ratio, a beneficial property for application as scaffolds, sensors, filters, membranes, batteries, protective clothing, wound dressing and catalyst (Fig. 4). In the early stages, applications in biomedical and tissue engineering field enlightened research on nanofibers. Over the years, applications were also extended to many fields based on the surface and chemical properties of nanofibers. Few applications of NFs prepared by E-spin technique.

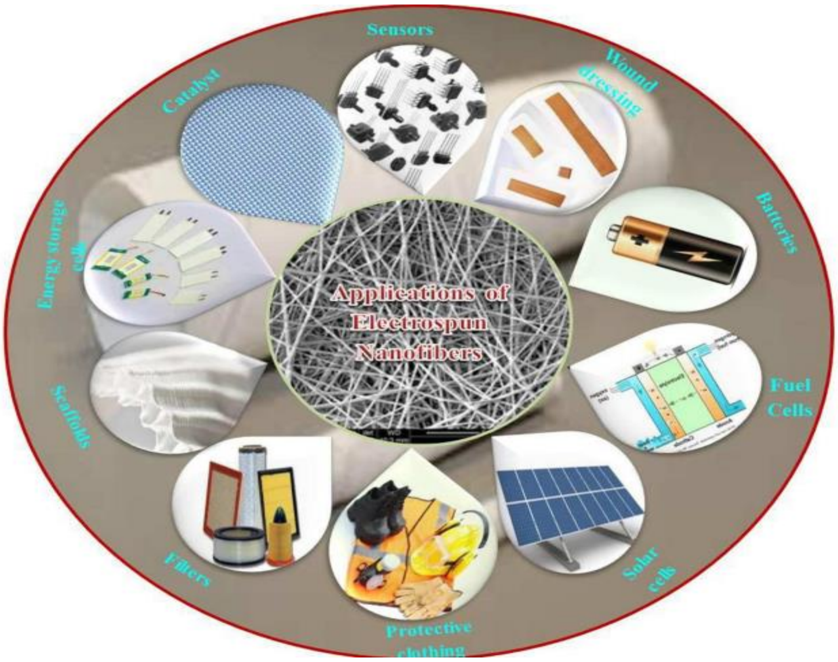


Fig. 4: Various applications of E-spun nanofiers

APPLICATION IN AGRICULTURE

a) SMART DELIVERY OF PESTICIDE BIOCONTROL AGENTS, PHEROMONES

Gao et. al., 2021 employed electrospun nanofibers to develop Thiram/hydroxypropyl-β-cyclodextrin inclusion complex (thiram/HPβCD-ICNF), a fast-dissolving drug delivery system. The thiram/HPβCD-IC-NF exhibited a fiber diameter ranging from 30 to 650 nm, with an average diameter of 270 ± 133 nm. SEM images depicted the electrospinning of thiram and HPβCD into consistent nanofibers without bead formations. The thiram/HPβCD-IC-NF (EC_{50} =0.403 ± 0.007 μg/mL) showed higher antifungal activity as compared to untreated thiram (EC_{50} =0.532 ± 0.013 μg/mL) against *Gibberella sp*.

Electrospinning with cellulose diacetate polymer (CDA) emerges as an efficient method for seed coating, facilitating the localized delivery of active ingredients. Electrospun cellulose diacetate (CDA) nanofibers incorporated with abamectin (Abm) and fluopyram (Flp) were used for coatings soyabean seeds. The SEM analysis showed that diameters for nanofibers incorporated with Abm and Flp, were 242 nm and 129 nm respectively. The release studies of abamectin and fluopyram from nanofibers revealed a slow and sustained release. There was no adverse effect on seed germination irrespective of coating thickness and uniformity. Functional performance, tested using fluopyram-loaded nanofibers in an *in vitro* fungal assay against the plant pathogen *Alternaria lineariae*, consistently inhibits fungal growth. The sustained release profile taken together with moisture stability suggests that nanofibrous seed coatings have a strong potential as an alternative platform to control plant pathogens such as nematodes and fungi (Barbara et. al, 2019).

Trimedlure, a pheromone of Medfly *Ceratitis capitata*, was incorporated in various electrospun nanofibres *viz.* ethyl cellulose, PCL, polyethylene glycol (PEG)-PCL and polyvinyl acetate–polyvinyl pyrrolidone (PVP) in the concentration range of 0.02–10% w/v. The field evaluation studies showed that the insect trapping was significantly higher in case of encapsulated pheromones (Bisotto-de-Oliveira et al. 2014)

b) DETECTION OF PESTICIDE RESIDUE

Feng et al, 2021 used novel electrospun fibers for development of nano/micro-structured pesticide detection card. The rapid detection card has reduced the detectable concentrations for carbofuran, malathion, and trichlorfon by 5-fold, 2-fold, and 1.5-fold respectively, as compared to the national standard values. This detection card has good storage stability and a low minimum detectable concentration, rapid detection, easy to operate as compared to the conventional detection techniques.

c) DNA EXTRACTION IN AGRICULTURE RESEARCH STUDIES

The traditional DNA extraction techniques used in agricultural research are time-consuming and tedious. The electro spun magnetic nanofibers helps in easy separation of magnetic DNA from other biomolecules (Nam et al, 2009). The electro spun nanofibers having positively charged membrane were used in extraction of DNA which is negatively charged biomolecule due to its phosphate groups. These electrospun nanofibres can be reused for DNA extraction, the extraction capacity was found 46% even after five cycles (Demirci et. al, 2014).

d) PREPARATION OF PROTECTIVE CLOTHING FOR FARM WORKERS

Electro spun nanofibrous membranes have shown immense potential for smart protective clothing. The new generation electrospun nanofibrous membranes based protective fabrics not only absorb or block toxic chemical but also detoxify them to reduce the risk of secondary contamination. The high specific surface areas of electrospun nanofibrous membranes help in attachment of functional compounds resulting in detoxification. Liquid pesticide entry was significantly reduced by fabrics laminated with electrospun polypropylene fiber layers which also have better water vapor permeability (Lee et al. 2006). Paraoxon, an organophosphate pesticide can easily be decomposed by protective clothing made of electrospun fibers having reactive species, (3-carboxy-4-iodosobenzyl) oxy-ˇ-cyclodextrin (Ramaseshan et al, 2006). The electrospun zinc titanate nanofibers were found reactive sorbents for detoxifying nerve and mustard agent simulant (Ramaseshan et al 2007).

CHALLENGES

The electro spun techniques has following disadvantages:

- *Requires large solvent:* Large amount of solvent requirement, solution electrospinning is predominately use for fabricating nanofibers which resulting in both economic and environmental concern.
- *Clogging of nozzle:* It is major challenge that limit e-spin technology for industrial production.
- *Reproducibility:* It is still difficult to produce uniform fiber reproducibly and at mass production level, while ensuring the desired size, morphology, structure and other properties.

FUTURE PERSPECTIVES

Optimization of simulation models regarding the electrospinning process by taking into consideration all the properties of a liquid for electrospinning and all the processing parameters to better elucidate the phenomenology of the electrified jets. There is a critical need to develop methods based on “green “solvents or even solvent-free systems. Further, it still remains a challenging task to generate nanofibers with diameters below 10 nm by electrospinning no matter which method is used. In this regard, computational modeling should offer insightful guidance for effectively downsizing the diameter of electrospun fibers.

REFERENCES

Bisotto-de-Oliveira, R., De Jorge, B. C., Roggia, I., Sant'Ana, J., & Pereira, C. N. (2014). Nanofibers as a vehicle for the synthetic attactant trimedlure to be used for ceratitis capitata wied:(Díptera, tethritidae) capture. *Journal of Research Updates in Polymer Science*, *3*(1), 40.

Chaudhary, K., & Kandasubramanian, B. (2022). Self-healing nanofibers for engineering applications. *Industrial & Engineering Chemistry Research*, *61*(11), 3789-3816.

Demirci, S., Celebioglu, A., & Uyar, T. (2014). Surface modification of electrospun cellulose acetate nanofibers via RAFT polymerization for DNA adsorption. *Carbohydrate polymers*, *113*, 200-207.

Fang, J., Niu, H., Lin, T., & Wang, X. (2008). Applications of electrospun nanofibers. *Chinese science bulletin*, *53*, 2265-2286.

Farias, B. V., Pirzada, T., Mathew, R., Sit, T. L., Opperman, C., & Khan, S. A. (2019). Electrospun polymer nanofibers as seed coatings for crop protection. *ACS Sustainable Chemistry & Engineering*, *7*(24), 19848-19856.

Feng, K., Zhai, M. Y., Wei, Y. S., Zong, M. H., Wu, H., & Han, S. Y. (2021). Fabrication of nano/micro-structured electrospun detection card for the detection of pesticide residues. *Foods*, *10*(4), 889.

Gao, S., Liu, Y., Jiang, J., Li, X., Ye, F., Fu, Y., & Zhao, L. (2021). Thiram/hydroxypropyl-β-cyclodextrin inclusion complex electrospun nanofibers for a fast-dissolving water-based drug delivery system. *Colloids and Surfaces B: Biointerfaces*, *201*, 111625.

Lee, S., & Kay Obendorf, S. (2006). Developing protective textile materials as barriers to liquid penetration using melt-electrospinning. *Journal of Applied Polymer Science*, *102*(4), 3430-3437.

Nam, J. H., Joo, Y. H., Lee, J. H., Chang, J. H., Cho, J. H., Chun, M. P., & Kim, B. I. (2009). Preparation of NiZn-ferrite nanofibers by electrospinning for DNA separation. *Journal of Magnetism and Magnetic Materials*, *321*(10), 1389-1392.

Noruzi, M. (2016). Electrospun nanofibres in agriculture and the food industry: a review. *Journal of the Science of Food and Agriculture*, *96*(14), 4663-4678.

Ramaseshan, R., & Ramakrishna, S. (2007). Zinc titanate nanofibers for the detoxification of chemical warfare simulants. *Journal of the American Ceramic Society*, *90*(6), 1836-1842.

Ramaseshan, R., Sundarrajan, S., Liu, Y., Barhate, R. S., Lala, N. L., & Ramakrishna, S. (2006). Functionalized polymer nanofibre membranes for protection from chemical warfare stimulants. *Nanotechnology*, *17*(12), 2947.

Raza, A., Li, Y., Sheng, J., Yu, J., & Ding, B. (2014). Protective clothing based on electrospun nanofibrous membranes. *Electrospun nanofibers for energy and environmental applications*, 355-369.

Thenmozhi, S., Dharmaraj, N., Kadirvelu, K., & Kim, H. Y. (2017). Electrospun nanofibers: New generation materials for advanced applications. *Materials Science and Engineering: B*, *217*, 36-48.

Zhao, Y., Zhang, J., Li, K., Ao, Z., Wang, C., Liu, H., ... & Wang, G. (2016). Electrospun cobalt embedded porous nitrogen doped carbon nanofibers as an efficient catalyst for water splitting. *Journal of Materials Chemistry A*, *4*(33), 12818-12824.

How to Cite:

Kundu, R., Narayanan, N. Rana, V. S., Shakil, A. N. and Kaushik, P. (2024). Electrospun nanofibers: new generation materials for pesticide delivery and detection. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):7-16.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

FOREST FIRE INCIDENTS IN THE CHANGING CLIMATIC SCENARIO

Tanvi Rajput, R K Aggarwal*, and Dheeraj Kumar
Department of Environmental Science
Dr Yashwant Singh Parmar University of Horticulture & Forestry Nauni, Solan (HP)
*Corresponding author email: rajeev1792@rediffmail.com

ABSTRACT

Forest fires pose a severe threat to biodiversity, ecosystems, and human settlements, particularly in biodiverse regions like Himachal Pradesh, India. The area faces increased risks due to prolonged dry spells and elevated temperatures, resulting in frequent incidents. Notably, 2019–2020 witnessed a surge in forest fires, with historical peaks in 1906. Climate change and human-related factors have led to substantial losses, reaching crores of rupees in Kullu. This study aims to enlighten policymakers on the escalating risk, offering insights for preventive measures. Two recent case studies underscore the urgency. The overarching goals include biodiversity preservation, mitigating forest fire impacts, and ensuring community safety.

INTRODUCTION

Himachal Pradesh, which lies in northwest India, is recognised for its ecological significance. Its latitude spans from 30º22' to 33º13' N and its longitude stretches from 75º36' to 79º02' E. It accommodates a varied range of temperate plants and animals and has a complicated topography and ecosystems. The state's entire area is 55,673 km^2. The documented forest area is approximately 66.5% (37,033 km^2), of which 1,898 km^2 are Reserved Forests, 33,130 km^2 are Protected Forests, and 2,005 km^2 are Unclassified Forests. The vegetation varies, with broad-leaf deciduous forests in the south and semi-desert, thorny scrub, and meadows in the north, confronting a growing threat of forest fires.

Fire is a natural force that alters vegetative communities over time and as a natural activity. Since the twentieth century, growing fires caused by human inattention have made fires the primary hazard to forests (Motazeh et al. 2013). These fires not only immediately threatened the ecosystems, crops, and residents in the area, but they also made it evident how urgently updated forest management and firefighting strategies need to be implemented. Global biodiversity, deforestation, and climate change are directly impacted by the growing frequency of forest fires. (Jazireie, 2005). Aside from the immediate harm to biodiversity, these fires pose a substantial risk to the region's agricultural industry, a critical source of subsistence for local residents. Himachal Pradesh. Forest fires have been occurring more frequently in the Himalayas for over thirty years. Both natural and human factors, such as lightning strikes, dry weather, and natural causes, influence the frequency of forest fires, but human activities such as illegal logging, burning of agricultural waste, and cigarettes that have been abandoned also greatly exacerbate the issue.

The state's diversified geography, including dense woods and steep regions, renders it susceptible to forest fires, which may negatively impact the environment, wildlife, and towns. In the summer of 2021, the Himalayas, particularly HP, a state noted for its lush forests and pristine vistas, were hit by a devastating series of forest fires.

(NDTV NEWS OF SOLAN)

Forest fires break during dry and summer months due to various natural and anthropogenic causes, including accumulations of inflammable materials such as dry leaves, twigs and pine needles or human carelessness such as throwing away smouldering match sticks or cigarette butts in forest areas. Excessive heat and an extended dry spell caused multiple wildfires in HP, destroying hectares of forest cover in numerous areas of the hill State. The State government's efforts to put down forest fires were significantly impeded by the early arrival of summer in 2022 in the hills, and due to the forecast of persistent dry weather and high temperatures, the task has grown increasingly challenging (The Hindu 2022).

FIRE INCIDENCES

The overall number of forest fires registered in HP increased from 4,110 in November 2020 to June 2021 to 5,280 in November 2022, according to data provided to the Lok Sabha by the MOEFCC. From the 536 fires that were reported in the state between November 2019 and June 2020, there has been a significant increase. The Forest Survey of India (FSI) estimates that woods accounted for 27.73 percent of HP total land area. Forest land accounts for 3.67 percent in Punjab and 3.63 percent in Haryana, respectively (The Tribune, 2022). The state's incidental fire count has been made accessible in Table 1.

Table 1: Year-wise number of fire incidences in HP

Sr. No.	Year	No of fire incidents
1	2018-19	2,544
2	2019-20	1,445
3	2020-21	1,045
4	2021-22	1,275

The highest number of forest fires in a year was 1,906 in the year 2009-10 till 2022. Himachal Pradesh recorded 2,763 fire incidents from April 1 to 30 June 2022, an average of 31 fires per day. About 23,239 hectares of forest area, which is about 0.45% of the state's land, were affected by these fire incidents (Gupta, 2022). A recent report from the HP Forest Department highlighted a concerning surge in forest fires across the state. Circle wise the highest number of forest fires was reported by FIRE (Fire Incident Reporting Enigine) in Chamba with the array of 269 fire incidences and the lowest was in Kullu with only 3 fire incidences in the year 2022-23. Whereas in the year 2023-24 the highest fire incidences of 36 was recorded in Chamba and the lowest was in Bilaspur. The report mentioned a staggering 1,195 incidents of forest fires so far in the year 2023, primarily concentrated in districts like Bilaspur, Chamba, Nahan, Rampur, Shimla, and Solan, each witnessing double-digit fire occurrences. Shockingly, these fires have ravaged forest wealth estimated at over Rs 2.88 crore. The impact is severe, with approximately 13,275.17 hectares of forest cover destroyed. This devastation includes 2,079.21 hectares of natural areas, 10,061.60 hectares of plantations, and 1,134.36 hectares of other forested areas. Furthermore, there have already been 263 forest fire incidents in the state during the current fiscal year 2023–2024., destroying 571.67 hectares of forested land. (Report from news nine Dec,2023). Table 2 revealed that the maximum number of forest fire incidents that occurred in 2019-20 was in Rampur Circle. The total losses were estimated to be 1.67 crore in the year 2019-20.

FOREST FIRE IN WINTERS

In Kullu, where it's time for snow, a recent forest fire illustrates how unexpected they can be in the winter. But due to some human error, a massive forest fire broke out in the Patlikuhal forest area of Kullu, destroying forest wealth worth crores of rupees. Soon after the fires in the forest expanded and grew intense. Large flames of fire were seen erupting out of the forest area and smoke spread in the area. Another fire incident was reported in Oachghat (Solan) where a large portion of the forest was under fire. The prolonged dry spell and low humidity helped in the spreading of forest fires in winter. and Attempts are underway to douse the fire. It's been three days since the fire started, engulfing the Patlikuhal forest from one hill to another. There were 75 VIIRS fire alerts reported in Kullu between the 7th of January 2024 and the 14th of January 2024, of which 6.7% were high-confidence alerts (Global Forest Watch).

Table 2: District-wise Forest Fire cases, affected areas and losses in the year 2019-20

Name of Circle	No. of Cases	Kind of Area Affected by Fire (in ha)			Total Area (in ha)	Estimated Loss (in Rs)
		Natural	Plantation	Other		
Bilaspur	132	31.00	92.70	558.28	681.98	1770000
Chamba	173	777.20	73.58	294.99	1145.77	1064810
Dharamshala	266	387.07	142.64	425.08	954.79	1349238
Hamirpur	129	198.00	240.80	395.59	834.39	1589240
Kullu	6	69.75	14.25	0.00	84.00	188649
Mandi	201	396.76	126.80	308.50	832.06	1930020
Nahan	126	856.43	128.00	8.00	992.43	1609885
Rampur	241	1264.50	631.02	358.60	2254.12	4987200
Shimla	129	671.12	154.45	0.00	825.57	1883650
Solan	34	267.00	52.80	0.00	319.80	265000
WL Dharamshala	2	0.00	2.00	1.00	3.00	0
WL Shimla	2	0.80	0.00	0.00	0.80	0
GHNP Shamshi	4	33.00	0.00	0.00	33.00	102000
Grand Total	**1445**	**4952.63**	**1659.04**	**2350.04**	**8961.70**	**16739692**

MITIGATION STRATEGIES BY THE FOREST DEPARTMENT

- The implementation of long-term tactics comprised utilizing a mass contact plan to involve locals or communities close to the fire area and a forest fire alert messaging system to send early alert messages to firefighters for prompt control.
- Short-term strategies involved the engagement of fire watchers in fire-sensitive beats, supply of forest fire equipment and control burning.
- Preparation and proper maintenance of fire lines in each forest area where chances of fire conflagration are more

SUGGESTION FOR MITIGATING FOREST FIRE

- Employing fire-resistant varieties of crops to boost agriculture’s resilience to forest fires.
- Converting woody plant matter like forest overgrowth, pine needles and agricultural waste material that is currently burned either naturally or manmade into solid biofuel like briquette for cooking and heating in domestic and industrial sectors while simultaneously preventing forest fires.

- The charcoal from pine needles will be useful for heating purposes.
- Adequate allocation of resources for firefighting equipment, trained personnel, and aerial firefighting capabilities is imperative to combat fires effectively.

CONCLUSION

The forest fires in Himachal Pradesh are a serious environmental and social issue that requires prompt attention and efficient response. Catastrophic fires not only harm biodiversity and ecological services, but they also disrupt local livelihoods, intensifying environmental degradation, and jeopardise public safety

REFERENCES

Ashish Verma. 2023. Raging fire since three days engulfs forests in mountains in Kullu. News Nine.

Global Forest Watch. 2023. Fire Alerts in Kullu Himachal Pradesh, India.

Himachal's ecology under pressure; around 31 forest fires per day in April-June this year

Jazireie MH. 2005. "Forest maintenance." Publishing and Printing Institute of Tehran University, Tehran, Iran.

Motazeh AG, Ashtiani EF, Baniasadi R and Choobar FM. 2013. Rating and Mapping Fire Hazard in the Hardwood Hyrcanian forests using GIS and expert choice software. *Forestry Ideas* 19: 141-50.

The Tribune News Service. 2022. Significant rise in forest fires in Himachal: Central report.

Vikas Vasudeva. 2022. Prolonged dry spell sparks wildfires across Himachal Pradesh. The Hindus Newspaper.

Vivek Gupta on 8 July 2022 Mongabay Series: The Indian Forest Story https://india.mongabay.com/

How to Cite:

Rajput, T., Aggarwal, R. K. and Kumar, D. (2024). Forest fire incidents in the changing climatic scenario. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):17-21.

*********XXXXX**********

Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

INSIGHTS INTO ORGANIC WEED MANAGEMENT IN AGRICULTURE

Ayan Sarkar[1*], Bhaskar Ghosh[2], and Abhijit Mandal[1]

[1]Division of Agronomy, Indian Agriculture Research Institute, New Delhi- 110012

[2]Division of Extension, Indian Agriculture Research Institute, New Delhi-110012

*Corresponding author email: ayan2020sarkar@gmail.com

ABSTRACT

Weeds pose a significant threat to agricultural production, causing nearly one-third of total losses attributed to pests. Certain crops, such as direct-seeded rice, may suffer complete yield loss due to weeds. While herbicidal weed management is effective and time-efficient, concerns over issues like resistance, pollution, and toxicity have led to a shift towards organic weed management. This holistic approach encompasses preventive, physical, cultural, biological, allelopathic, and organically derived herbicidal methods. Combining preventive measures, physical techniques like hand weeding and mulching, cultural practices, biological control, and allelopathy offers a comprehensive, synthetic herbicide-free strategy, suitable for diverse agricultural systems such as organic and natural farming, where weeds pose a significant hindrance to productivity.

INTRODUCTION

Management of weeds in all agro-ecosystems is imperative in order to sustain our crop productivity and to ensure food security as losses due to weeds accounts for about one-third of the total losses caused by agricultural pests. In certain cases, like in direct seeded rice (DSR), weeds can cause up to 100% yield loss. Among different weed management options, herbicidal based weed management is the very popular as it is quite effective in managing weeds and simultaneously saves considerable time and labour. But like other pesticides, over-reliance on herbicide has received criticism for different issues like:

- evolution of herbicide resistance in weeds
- weed species population shifts
- surface and groundwater water pollutions
- herbicide residues in food chain
- toxicity on non-target organisms

- risk in cropping systems

The increased concerns about side effects of herbicides have dominantly driven the focus on organic weed management. Organic weed management is basically a multi-hammer approach that is basically a multiple weed suppression tactics that are individually weak but cumulatively strong. Thus it is just opposite to chemical weed management option that relies on single hammer approach. Organic weed management consists of various preventive, physical, cultural or ecological, biological, allelopathic and organically derived chemical-based approach to tackle weeds.

WEED SCOUTING

It is an important step in any type of weed management. Understanding type of weed populations present in a field, their growth stage, and infestation severity is very important as it is the basis of any type of decision taking related to weed management. Many weed species are only effectively controlled when they are small, so timely scouting finds small, susceptible weed seedlings present in a field. Additionally early identification of new species, provides opportunity to control them before they move within the field or to other fields. Weed scouting should not be limited to the current growing season, but throughout the year preferably conducted twice during each growing season, once following planting but prior to the first weeding and then just prior to harvest. (Vangessel, 2019)

For start of successful weed management strategy, following steps are essential:

1. Walk a zig-zag pattern through the field, stopping at least 5 times at widely-separated points along the way.
2. While walking through the field, identify all weed species present and record the growth stage of each weed.
3. If the weeds appear to be concentrated in specific areas of the field, draw a map of the field and mark their locations.
4. At each field stop, determine the number of weeds present
5. After taking data on their degree of dominance, take decision on which methods can be incorporated in managing them.

PREVENTIVE APPROACH OF ORGANIC WEED MANAGEMENT

There is a saying that ‘Prevention is better than cure’. Preventive options consist of a number of tactics like at the time of sowing, use weed free certified crop seeds, well decomposed FYM and compost; during the growing season, use of clean (weed seed free) irrigation water, keep the irrigation channel and bunds free of weed infestation; at the time of harvest, use clean harvest and grain transporting equipment etc. Other than this, impose strict quarantine law, stale seed bed, use clean farm machinery and farm animal etc needed to be ensured.

PHYSICAL METHODS OF ORGANIC WEED MANAGEMENT

Physical method of weed management is the combination of mechanical and manual method of weed management. Hand weeding is the most common method of organic weed management. It effectively controls annual weeds with upright and erect growth and not suitable for weeds growing horizontally prostrate & rosette as they may get cut off at the base on pulling by hands and may rejuvenate later. Hand hoeing is a post-planting intercultural operation, require less manpower than hand weeding. It is effective more against annual weeds than against perennial weeds. Tillage also effectively controls perennial weeds. Mulching exclude sunlight from reaching to soil by covering it and to germinating weeds, whose photosynthesis inhibited causing them to die. They also work as effective barrier to weed emergence. It is very effective against most annual weeds and some perennial weeds such as *Cynodon dactylon*, *Sorghum halepense*. Other physical method of weed management are cheeling and digging, flooding, burning, flaming, mowing and slashing etc.

CULTURAL/ECOLOGICAL METHODS OF ORGANIC WEED MANAGEMENT

Cultural or ecological method is based on the principle ‘a good crop is the best weed killer’. It relies on crops competitiveness and management practices which gives the crop more favourable environment. Strategies like selecting weed competitive crop types, varieties, modifying sowing time and method that favours crop over weeds, adjusting seed rate, crop rotation, use of trap and catch crops, following cropping patter that discourage weed emergence, irrigation timing and methods, modifying fertilizer application rate, method, time that stimulate crops over weeds, summer fallowing etc are the different strategies that need to be considered in organic weed management.

BIOLOGICAL METHODS OF ORGANIC WEED MANAGEMENT

It relies on the natural law of homeostasis, that is check and balance. It focuses on managing a organism (weeds) using another living organism up to a population density lower than what naturally occurs in the absence of the employed organism. This method is not suitable in crop land situation, but can be used in non-crop situation. Various insects and beneficial micro-organism can be used in biologically managing weeds.

Bio agents	Target organism
Insects	
Zygrogramma bicolarata	*Parthenism hysterophorus*
Crocidosema lantana, Teleonnemia scrupulosa	*Lantana camara*
Neochetina eichhornea, N. Bruchi	*Eichhornea crassipes*
Agasides hygrophilla	*Alternanthera philoxaroides*
Crytobagus singularis , Paulinia acuminate	*Salvinia molesta*
Microorganisms	
Phyophthora palmivora (Devine)	*Morreria odorata* (Strangler vine) in citrus
Colletotrichum gleosporoidesf.sp. aeschynomene (Collego)	*Aeschynomene virginica* (northen joint vetch) in rice and soyabean
Colletotrichum gleosporoides f.sp. Cuscuttae (LUBAO 11)	*Cuscutta sp.* (Dodder)
Cercospora rodmanii (ABG 5003)	*Eichhornea crassipes* (water hyancinth)

(Ravisankar et al.,2017)

ORGANICALLY DERIVED HERBICIDE BASED WEED MANAGEMENT

Organically derived herbicides can be a very potential tool in organic weed management. They are obtained from natural sources, so can be used in organic farming as well. But the main problem of these type of compound is that, most of them are non-selective, which restricts its use in crop land situation, but can be applied in non-crop situation. These need to be applied, either prior to crop emergence or transplanting, or post-directed application in established crops to assure the herbicides do not injure the crop plant. In general, these contact herbicides control broadleaf weeds better than grasses, and annual weeds better than perennial weeds. These herbicides destroy the plant's waxy cuticle and cell walls causing desiccation and rapid wilting. Example of some organically derived herbicides along with time of application is given as below:

Organically derived herbicides	Time of application
Corn gluten meal	Pre emergence
Mustard seed meal	Pre emergence
Vinegar (5, 10, 15 and 20% acetic acid) like Weed Pharm® (20% Acetic Acid)	Post emergence
Clove oil (Matratec®, and Matran®, 50% Clove Oil)	Post emergence
D-limonene (GreenMatch® 55% d-limonene)	Post emergence
Caprylic/capric acid (Suppress®)	Post emergence
Eugenol (Weed Slayer®)	Post emergence

(Webber, 2012; www.extension.colostate.edu)

ORGANIC WEED MANAGEMENT USING ALLELOPATHY

Allelopathy is based on the fact that plants produce many secondary bi-products which released in the the surrounding environment either via leaching or exudation or through decomposition of residue. These compounds have the ability to possess negative or positive impact on growth of other plants. For example- Some crops, such as Rye, Sunflower, Buckwheat, Black mustard etc can be used for controlling different weeds via allelopathy. Several allelochemicals like gallic acids, protocateuic acid, syringic acid, benzoic acid, dhurrin, sorgoleone etc present in sorghum water extract (sorgaab). Similarly, chlorogenic acid, isochlorogenic acid, scopolin etc present in Sunflower water extract. They can be used as foliar spray for managing weeds. Allelopathy may be employed for weed control in field crops by combining cropping, intercropping, surface mulch, soil incorporation of plant residues, allelopathic aqueous extracts etc. (Arif et al.,2015)

ORGANIC PARASITIC WEED MANAGEMENT

Parasitic weeds are special kind of crop bound weeds which depend on crops directly for survival during their partial life time or complete life time. A number of options available for managing the parasitic weeds.

Parasitic weeds	**Management strategy**
Cuscuta spp	i) Crop rotation with wheat,barley, oats or with winter pulses like gram lentil etc. ii) Tolerant variety like for lucerne, ‘T**9’**; for green gram, ‘**M2’;** for linseed, ‘**Garima’** iii) Soil solarization
Orobanche spp	i) Crop rotation with non-host crop like wheat, barley, chickpea ii) Trap crop like Pepper for *O.cernua* , Linseed for *O .ramosa* ; Catch crop like Toria. iii) Soil solarization iv) Tolerant varieties like **‘F-402’** of Fababean .
Striga spp	i) Crop rotation with soybean, cowpea, cotton, sunflower; intercropping of sorghum with desmodium and napier grass on border **(Push and pull strategy),** ; green manuring with sunnhemp etc ii) Minimum or Zero tillage iii) Soil solarization

ORGANIC WEED MANAGEMENT FOR AQUATIC WEEDS

Aquatic weeds are one of the major hindrances in fishery, they decrease the value of wetlands, harbour a number of disease-causing vectors etc. A number of options available for managing them organically like, mechanical methods consisting of chaining and dredging, netting, mowing etc; biological methods use of Grass carp *(Ctenopharyngodon idella*), Snails (belonging to genera *Marisa* and *Pamacea*), Ducks, Manatees. Insects (*Neochetina eichhorniae* for *Eichhornia crassipes*) etc can be done.

CONCLUSION

Organic weed management is indeed a potential alternative to chemical weed management, if implemented properly. Integrated application of different organic weed management tactics may provide better result rather than relying on any of individual option. More intensive research and developments are needed in area of biological control and allelopathy mediated weed control to expand their use and effective field applicability. Further, in recent future, exploiting latest options/concepts like 'weed suppressive soil', robotics assisted welders can be a way forward in this field.

REFERENCES

Arif, M., Cheema, Z., Khaliq, A. & Hassan, A. 2015. Organic weed management in wheat through allelopathy. *International Journal of Agriculture and Biology* **17**(1): 127-134.

https://extension.colostate.edu/docs/pubs/crops/00314.pdf

Ravisankar, N., Panwar, A.S., Prasad, K., Kumar, V.&. Bhaskar, S. 2017. Organic Farming Crop Production Guide, Network Project on Organic Farming, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut-250 110, Uttar Pradesh, India.

VanGessel, M. (2019) A Practical Guide for Integrated Weed Management in Mid Atlantic Grain Crops, Technical bulletin published by USDA. https://growiwm.org/wp-content/uploads/2019/10/IWMguide.pdf?x71059

Webber, C.L. III & J.W. Shrefler. (2007) Corn gluten meal applicator for weed control in organic vegetable production. *Journal of Vegetable Crop Production* 12:19-26

How to Cite:

Sarkar, A., Ghosh, B., and Mandal, A. (2024). Insights into organic weed management in agriculture. Leaves and Dew Publication, New Delhi 110059. Agri Journal World, 4(2):22-27.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

INTERNATIONAL INITIATIVES TO CURB GREENHOUSE GAS EMISSIONS AND COMBAT CLIMATE CHANGE

Athulya S

Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agriculture Research Institute, New Delhi-110012

Corresponding author email: athulyaspillai2309@gmail.com

ABSTRACT

The current global challenges of the greenhouse effect and global warming stem from the accumulation of greenhouse gases, including water vapor, carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. Human-induced activities, such as deforestation, fossil fuel combustion, and industrial emissions, intensify this natural phenomenon, accelerating global warming and consequent climate change. Recognizing the urgency of the issue, international efforts, exemplified by global climate change summits and agreements, aim to establish binding targets and a unified approach. Innovative strategies, such as carbon credits and trading within Emissions Trading Systems (ETS), offer a tangible means to curb greenhouse gas emissions. These credits represent prevented carbon dioxide emissions and contribute to the global endeavor of mitigating climate change.

INTRODUCTION

The greenhouse effect is the natural warming of the earth that results when gases in the atmosphere trap radiation from the sun that would otherwise escape into space. During the day, the sun shines through the atmosphere, warming earth's surface. At night, the earth's surface cools, releasing heat back into the air and some of this heat is trapped by the greenhouse gases in the atmosphere. This process makes earth much warmer than it would be without an atmosphere (14˚C instead of -18˚C). The gases that trap the outgoing radiation are greenhouse gases which entail water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFC) mainly (Table 1). Though the greenhouse effect is a natural phenomenon, due to erroneous human activities such as clearing forests, burning fossil fuels, releasing industrial gases to the atmosphere, *etc*., the emission of greenhouse gases is increasing at an alarming rate. This has in turn resulted in global warming. Global warming is the unusual rapid increase in earth's average surface temperature primarily due to greenhouse effect. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to human activities which has resulted in climate change which refers to long-term shifts in atmospheric temperature and weather patterns. Climate change caused by greenhouse gas emissions is, by its very nature, a global issue. A common strategy and binding targets must therefore be defined on a planetary scale to effectively combat global warming and climate change. This has been the aim of many international climate change initiatives, from the Earth Summit in Rio in 1992 to the universal Paris Agreement adopted in December 2015 and the annual COPs.

Table 1: Greenhouse gases, their concentration in atmosphere and global warming potential

Greenhouse Gases	Atmospheric concentration	Global Warming Potential (GWP)
CO_2	401 ppm	1
Methane	1780 ppb	25
Nitrous oxide	319 ppb	298
CFC 11	250 ppt	4600
CFC 12	553 ppt	10600
HCFC 22	132 ppt	1700
HCFC 23	12 ppt	12000

INTERNATIONAL INITIATIVES TO REDUCE GREENHOUSE GAS EMISSIONS AND COMBAT CLIMATE CHANGE

1) United Nations Framework Convention on Climate Change (UNFCCC)

In 1992, 194 countries joined this international treaty to address the problem of climate change. This is also known as Rio Earth Summit. Stabilizing atmospheric concentrations of greenhouse gases to avoid dangerous anthropogenic interference was the aim of this summit. The headquarters is at Bonn, Germany. The components of UNFCCC are COP, Secretariat, Expert Groups, Financing and the Global Environment Facility and Subsidiary bodies. The principles of UNFCCC are to reduce overall climate impact, educate for climate action, promote sustainable and responsible consumption and advocate for climate action through communication.

2) Kyoto Protocol

The Kyoto Protocol, the first international treaty to set legally binding targets to cut greenhouse gas emissions, was adopted on 11 December 1997. Owing to a complex ratification process, it entered into force on 16 February 2005 and had 192 member countries. The Kyoto Protocol operationalized the United Nations Framework Convention on Climate Change by committing industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets. In its Annex B, the Kyoto Protocol had set binding emission reduction targets for 37 industrialized countries and these targets added up to an average 5 per cent emission reduction compared to 1990 levels over the five-year period 2008–2012 (the first commitment period). To enable countries to meet their emissions reduction targets, the Kyoto Protocol established three market-based mechanisms: emission trading, clean development mechanism and joint implementation mechanism. In Doha, Qatar, on 8 December 2012, the Doha Amendment to the Kyoto Protocol was adopted for a second commitment period; however, Kyoto Protocol has been superseded by the Paris Agreement in 2015.

3) The Cancun agreements

The Cancun Agreements were a set of significant decisions by the international community to address the long-term challenge of climate change collectively and comprehensively over time, and to take concrete action immediately to speed up the global response to it. The agreements, reached on December 11 in Cancun, Mexico, at the 2010 United Nations Climate Change Conference, represented key steps forward in capturing plans to reduce greenhouse gas emissions, and to help developing nations protect themselves from climate impacts and build their own sustainable futures. It encompassed finance, technology and capacity-building support to help countries meet urgent needs to adapt to climate change, and to speed up their plans to adopt sustainable paths to low emission economies that could also resist the negative impacts of climate change.

The goals include,

- Establish clear goals and a timely schedule for reducing human-generated greenhouse gas emissions over time to keep the global average temperature rise below two degrees
- Encourage the participation of all countries in reducing these emissions, in accordance with each country's different responsibilities and capabilities to do so
- Mobilize the development and transfer of clean technology to boost efforts to address climate change, getting it to the right place at the right time and for the best effect on both adaptation and mitigation

- Set up the Green Climate Fund to provide support to developing countries to assist them in mitigating climate change and adapting to its impacts
- Protect the world's forests, which are a major repository of carbon; governments have agreed to launch concrete action on forests in developing nations, which will increase going forward.

4) The Durban Agreements

The UN Climate Change Conference in Durban was a turning point in the climate change negotiations. In Durban, governments clearly recognized the need to draw up the blueprint for a fresh universal, legal agreement to deal with climate change beyond 2020, where all would play their part to the best of their ability and all will be able to reap the benefits of success together. The Durban outcome recognized, in its spirit and intention that smart government policy, smart business investment, and the demands of an informed citizenry, all motivated by an understanding of mutual self-interest, must go hand in hand in pursuit of the common goal. The key goals include,

i) Second commitment period of the Kyoto Protocol

The continuation of the current international legal system through a second commitment period of the Kyoto Protocol, under which developed countries commit to greenhouse gas cuts and which enshrines existing accounting rules and models of international cooperation that may inform future efforts.

ii) Launch of new platform of negotiations

The launch of a new platform of negotiations under the Convention to deliver a new and universal greenhouse gas reduction protocol, legal instrument or other outcome with legal force for the period beyond 2020. This new negotiation critically includes finding ways to further raise the existing level of national and international action and stated ambition to bring greenhouse gas emissions down.

iii) Global Review

To scope out and then conduct a fresh global Review of the emerging climate challenge, based on the best available science and data, first to ensure whether a maximum two-degree rise is enough or whether an even lower 1.5-degree rise is required, and then to ensure that collective action is adequate to prevent the average global temperature rising beyond the agreed limit.

5) Rio Plus 20 Summit

The United Nations Conference on Sustainable Development (UNCSD), also known as Rio 2012 or Rio+20 or Earth Summit 2012 was the third international conference on sustainable development aimed at reconciling the economic and environmental goals of the global community. Hosted by Brazil in Rio de Janeiro from 13 to 22 June 2012, Rio+20 was a 20-year follow-up to the 1992 United Nations Conference on Environment and Development (UNCED) held in the same city, and the 10th anniversary of the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg. The objective of the Rio plus 20 conference was to secure renewed political commitment for sustainable development addressing new and emerging challenges, with a focus on two key themes:

i) Green Economy in the context of sustainable development and poverty eradication

The Green economy is based on six main sectors:

- Renewable energy (solar, wind, geothermal, marine including wave, biogas, and fuel cell)
- Green buildings (green retrofits for energy and water efficiency)
- Clean transportation (alternative fuels, public transit, hybrid and electric vehicles, car sharing and carpooling programs)
- Water management (Water reclamation, low-water landscaping, water purification, storm water management)
- Waste management (recycling, municipal solid waste management)
- Land management (organic agriculture, habitat conservation and restoration, urban forestry)

ii) The institutional framework for sustainable development

6) The Paris Agreements

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12 December 2015. It entered into force on 4 November 2016. Its overarching goal is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels." With the Paris Agreement, countries established an enhanced transparency framework (ETF). Under ETF, starting in 2024, countries will report transparently on actions taken and progress in climate change mitigation, adaptation measures and support provided or received. It also provides for international procedures for the review of the submitted reports. The information gathered through the ETF will feed into the Global stocktake which will assess the collective progress towards the long-term climate goals.

7) Carbon Credits and Carbon Trading

Kyoto Protocol (1992) introduced the concept of carbon credits as per which a country gets credits to reduce carbon emissions in the atmosphere. It was signed in 1997 in Kyoto, Japan. Carbon credits work like most commodities – they're tradable units or certificates. To be more specific, they are a permit that gives its holder the right to emit certain amounts of carbon dioxide or its equivalent (CO_2), such as nitrous oxide, methane, etc. One carbon credit represents 1 metric ton of CO_2 prevented from entering the atmosphere. Individuals and companies buy them to compensate for their unavoidable emissions. They're from projects or activities that reduce or remove carbon emissions from the air. Carbon credits traded in an ETS (Emissions Trading System) are from various projects certified and verified by carbon standards such as Verra, Gold Standard, Puro earth and American Carbon Registry, among others. For developing nations, carbon credits are issued in the form of Certified Emission Reductions (CERs). Each CER is awarded for each ton of GHG that a project reduces, avoids, or removes. These carbon credits, measured in Mt of CO_2, are issued by UNFCCC. Anyone can buy these carbon credits on this platform to offset their emissions or they can do so just to support or finance the carbon reduction or removal projects. In addition to this, the trade has led to using carbon accounting to measure the impact made by companies, individuals, and governments on greenhouse gas reduction.

CONCLUSION

Global warming refers to the gradual rise in overall temperature of the earth's atmosphere. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to erroneous human activities which has resulted in climate change (long-term shifts in atmospheric weather patterns). Strategies and binding targets defined on a planetary scale were mandatory to effectively combat global warming and climate change. Various summits were held; treaties and agreements were signed on a global level to reduce greenhouse gas emissions and combat climate change. Carbon credits and carbon trading were introduced as well; as novel initiatives to cut down greenhouse gas emissions. Carbon credits are tradable units or certificates that gives its holder the right to emit certain amounts of carbon dioxide or its equivalent, *viz.* as nitrous oxide, methane, *etc.* A single carbon credit is equivalent to one metric ton of CO2 that is kept out of atmosphere. A carbon market allows investors and corporations to trade carbon credits. This acts as a mitigating measure to combat climate change, while creating new market opportunities as well.

BIBLIOGRAPHY

Abbass, K., Qasim, M. Z., Song, H., Murshed, M., Mahmood, H., & Younis, I. (2022). A review of the global climate change impacts, adaptation, and sustainable mitigation measures. Environmental Science and Pollution Research, 29(28), 42539-42559.

Fawzy, S., Osman, A.I., Doran, J. and Rooney, D.W., 2020. Strategies for mitigation of climate change: a review. Environmental Chemistry Letters, 18, pp.2069-2094.

VijayaVenkataRaman, S., Iniyan, S., & Goic, R. (2012). A review of climate change, mitigation and adaptation. Renewable and Sustainable Energy Reviews, 16(1), 878-897.

Zheng, X., Streimikiene, D., Balezentis, T., Mardani, A., Cavallaro, F., & Liao, H. (2019). A review of greenhouse gas emission profiles, dynamics, and climate change mitigation efforts across the key climate change players. Journal of Cleaner Production, 234, 1113-1133.

How to Cite:

Athulya S. (2024). International initiatives to curb greenhouse gas emissions and combat climate change. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):28-34.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

ROLE OF PLANT HORMONES IN CONTROLLING FRUIT DEVELOPMENT AND MATURATION

Anamika Pandey[1]* and Vijay Bahadur[2]

[1]Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences. Naini, Prayagraj.

Corresponding author email: anamika7067pandey@gmail.com

ABSTRACT

Fruit development is a meticulously orchestrated process influenced by plant hormones, governing growth, maturation, and quality. This review explores the pivotal role of auxins, cytokinins, gibberellins, abscisic acid (ABA), and ethylene in various stages of fruit development. Auxins drive cell elongation and apical dominance, essential for fruit size and structure. Cytokinins regulate cell division, impacting fruit set and delaying senescence. Gibberellins contribute to fruit size, shape, and seedless fruit formation. ABA, responding to environmental stress, influences water regulation crucial for fruit maturation. Ethylene acts as the "ripening hormone," governing color change, flavor, and texture. Understanding hormonal interplay is vital for optimizing fruit development.

INTRODUCTION

Fruit development is a fascinating and intricately orchestrated process within the life cycle of plants. From the tiny flower bud to the ripe, succulent fruit, this journey involves a series of precisely regulated events. Understanding the role of plant hormones in this developmental saga unlocks the secrets behind the growth, maturation, and quality of fruits. In this introduction, we will delve into the significance of comprehending plant hormones and provide a brief glimpse into the key players shaping the destiny of fruit. The journey from flower to fruit is a complex biological transformation governed by a multitude of factors. It encompasses stages such as pollination, fertilization, and embryonic development, eventually culminating in the formation and maturation of the fruit. Each stage involves a delicate interplay of physiological, biochemical, and molecular events, where plant hormones act as molecular messengers, orchestrating the symphony of fruit development.

KEY PLANT HORMONES

Several key plant hormones play pivotal roles in shaping the destiny of fruits. Auxins, for instance, are crucial for cell elongation and overall growth. Cytokinins regulate cell division and influence fruit set, while gibberellins contribute to fruit size and shape. Abscisic acid (ABA) plays a dual role in stress responses and seed development. Finally, ethylene, often referred to as the "ripening hormone," is a master regulator of fruit ripening. In this exploration, we will delve into the specific functions and interactions of these hormones, unveiling the molecular mechanisms that govern the captivating journey from flower to delectable fruit.

THE PLAYERS - KEY PLANT HORMONES

AUXINS

Auxins are a class of plant hormones that play a fundamental role in regulating plant growth and development. They are primarily produced in the apical meristems of shoots and young leaves, influencing various aspects of plant physiology. The primary auxin found in plants is indole-3-acetic acid (IAA).

Specific Role in Fruit Development:

1. **Cell Elongation:** One of the primary functions of auxins is to promote cell elongation. In the context of fruit development, auxins contribute to the expansion of cells, influencing the overall size and shape of the fruit. For example, in fleshy fruits like tomatoes, auxins aid in the elongation of cells, contributing to the plumpness and size of the mature fruit.
2. **Apical Dominance:** Auxins are involved in apical dominance, where the terminal bud suppresses the growth of lateral buds. In fruit trees, this influences the distribution of resources and, consequently, the formation and development of fruits on different branches.
3. **Fruit Setting:** Auxins play a crucial role in fruit setting, ensuring the proper initiation and development of seeds within the fruit. Adequate auxin levels are essential for the growth and development of the ovary into a mature fruit.

CYTOKININS

Functions in Plant Growth:

Cytokinins represent a class of plant hormones crucial for various aspects of plant growth and development. They are synthesized primarily in the roots, and their movement is directed towards the shoots, influencing processes such as cell division, shoot initiation, and leaf expansion.

Influence on Fruit Maturation:

1. **Cell Division:** One of the primary functions of cytokinins is to promote cell division. In the context of fruit development, cytokinins play a role in the proliferation of cells, contributing to the overall growth of the fruit. This is particularly crucial during the early stages of fruit formation when rapid cell division is essential for proper fruit development.
2. **Delaying Senescence:** Cytokinins have been found to delay senescence, the process of aging and deterioration in plant tissues. In the context of fruit maturation, this property can influence the timing

of fruit ripening. By slowing down the aging process, cytokinins contribute to the prolonged quality and shelf life of fruits.

3. **Enhancing Fruit Set:** Cytokinins are involved in promoting fruit set, ensuring a higher number of fruits are successfully initiated and mature. Their influence on cell division and differentiation contributes to the formation of a well-developed and healthy fruit structure.

GIBBERELLINS

Impact on Fruit Size and Shape:

Gibberellins, a group of plant hormones, exert a profound influence on various aspects of plant growth and development, including fruit size and shape. These hormones are synthesized in meristematic regions, young leaves, and developing seeds.

1. **Cell Elongation:** Gibberellins play a crucial role in promoting cell elongation, especially in the context of fruit development. By stimulating cell expansion, gibberellins contribute to the enlargement of fruit cells, resulting in an increase in fruit size. This is particularly evident in elongated fruits such as bananas and grapes, where gibberellins contribute to elongating the individual cells, shaping the overall structure of the fruit.
2. **Seedless Fruit Formation:** Gibberellins are involved in the development of seedless fruits. In some cases, applying gibberellins can induce parthenocarpy, the development of fruit without fertilization. This is valuable in horticulture, as it allows for the production of seedless fruits, such as seedless grapes or seedless watermelons.

ABSCISIC ACID (ABA)

Stress Responses and Fruit Maturation:

Abscisic Acid (ABA) is a multifaceted plant hormone known for its involvement in stress responses and its intricate role in fruit maturation.

1. **Environmental Stress Response:** ABA plays a pivotal role in plants' response to environmental stresses such as drought, salinity, and extreme temperatures. In the context of fruit development, elevated levels of ABA can be triggered by environmental stressors. This adaptive response helps the plant prioritize resources and may influence the timing and quality of fruit maturation under challenging conditions.
2. **Water Regulation:** ABA is particularly crucial in regulating water balance within the plant. During water stress, increased ABA levels prompt the closure of stomata, reducing water loss through

transpiration. This water-saving mechanism ensures that the plant can allocate resources effectively, influencing the development and maturation of fruits.

ETHYLENE

The "Ripening Hormone":

Ethylene, often referred to as the "Ripening Hormone," is a gaseous plant hormone with a central role in the regulation of fruit ripening.

Ethylene's Regulatory Role in Fruit Ripening:

1. **Initiation of Ripening:** Ethylene serves as a trigger for the initiation of the ripening process. It activates the expression of genes involved in various ripening-associated changes, including color transformation, flavor development, and texture changes.
2. **Color Change and Chlorophyll Breakdown:** Ethylene plays a key role in the regulation of pigments in fruits. It promotes the breakdown of chlorophyll, leading to the loss of green color and the emergence of characteristic colors associated with ripening, such as red, orange, or yellow.
3. **Flavor and Aroma Development:** Ethylene influences the production of volatile compounds responsible for the characteristic flavor and aroma of ripe fruits. This includes the synthesis of
4. sugars, acids, and aroma compounds, contributing to the appealing sensory attributes of mature fruits.
5. **Softening of Fruit Tissues:** Ethylene induces the softening of fruit tissues by activating enzymes involved in cell wall modifications. This process is crucial for enhancing fruit palatability and texture.

THE ROLE OF PLANT HORMONES IN FRUIT DEVELOPMENT

Fruit Enlargement and Shape

Hormonal Coordination in Fruit Shaping:

1. **Synergy with Auxins and Cytokinins:** The hormonal coordination in fruit shaping involves a synergistic interplay between gibberellins, auxins, and cytokinins. While gibberellins primarily stimulate cell elongation, auxins contribute to cell enlargement and overall fruit growth, and cytokinins regulate cell division. This collaboration ensures a balanced and harmonious development of the fruit, resulting in optimal size and shape.
2. **Environmental Influences:** The hormonal coordination in fruit shaping can be influenced by environmental factors, including light, temperature, and nutrient availability. Understanding how these external elements interact with hormonal signals is essential for horticulturists seeking to optimize fruit size and shape under varying conditions.

HORMONAL REGULATION DURING FRUIT RIPENING

Initiation of Ripening

Ethylene as the "Master Regulator":

1. **Climacteric Fruits:** Ethylene, often hailed as the "Ripening Hormone," takes center stage in the initiation of fruit ripening, particularly in climacteric fruits. Climacteric fruits, such as tomatoes and bananas, exhibit a sharp increase in ethylene production at the onset of ripening.
2. **Autocatalytic Effect:** Ethylene's role in the initiation of ripening involves an autocatalytic effect. As the fruit begins to produce ethylene, this gaseous hormone accelerates its own synthesis, creating a positive feedback loop that propels the fruit into the ripening phase.
3. **Switch to Respiratory Climacteric:** Ethylene triggers a metabolic shift in the fruit, known as the respiratory climacteric. This phase is marked by a surge in respiration rate, accompanied by various biochemical and physiological changes, including the conversion of starches to sugars, degradation of chlorophyll, and softening of fruit tissues.

Interactions with Other Hormones:

1. **Synergy with Auxins:** Ethylene interacts with auxins during the initiation of ripening. While auxins contribute to fruit growth, ethylene signals the transition from growth to ripening. This synergy ensures a smooth and coordinated shift in the fruit's physiological state.
2. **Impact on Gibberellins:** Ethylene's influence extends to gibberellins, another group of plant hormones. Ethylene can suppress the activity of gibberellins, particularly in the context of climacteric fruits. This interaction plays a role in coordinating the complex biochemical processes associated with ripening, including changes in color, flavor, and texture.

3. **Cross-Talk with Abscisic Acid (ABA):** Ethylene engages in cross-talk with abscisic acid (ABA) during the initiation of ripening. While ethylene is associated with the onset of ripening, ABA may influence the timing and progression of this process. The intricate interplay between these hormones contributes to the nuanced regulation of fruit ripening.

COLOR CHANGE AND FLAVOR DEVELOPMENT

Anthocyanins and Carotenoids:

1. **Anthocyanins for Vibrant Colors:** The transition from unripe to ripe fruits involves a captivating interplay of pigments. Anthocyanins, responsible for red, purple, and blue hues in fruits, play a crucial role in color change during ripening. Their accumulation imparts vibrant and appealing colors to fruits like cherries, grapes, and berries.
2. **Carotenoids for Warm Tones:** Carotenoids contribute to the warm tones of yellow, orange, and red in fruits. As chlorophyll breaks down, carotenoids become more visible, leading to the characteristic color changes observed in fruits like oranges, tomatoes, and mangoes during ripening.

Ethylene and ABA in Flavor Formation:

1. **Ethylene's Impact on Flavor:**

- **Influence on Aroma Compounds:** Ethylene significantly influences the formation of volatile compounds responsible for fruit aroma. As fruits ripen, ethylene stimulates the production of esters, aldehydes, and other aromatic molecules, enhancing the overall flavor profile.
- **Softening and Texture Changes:** Ethylene contributes to the softening of fruit tissues by activating enzymes involved in cell wall modifications. This process influences the texture of the fruit, impacting its palatability and mouthfeel.

2. **ABA's Role in Flavor Development:**

- **Enhancement of Sugar Accumulation:** Abscisic acid (ABA) contributes to the development of sweetness in ripe fruits by enhancing the accumulation of sugars, such as sucrose and glucose. This is crucial for the development of a well-balanced and flavorful fruit.
- **Acid Regulation:** ABA plays a role in acid regulation, influencing the balance between sweetness and acidity in fruits. This balance contributes to the overall taste perception and quality of the ripe fruit.

SOFTENING AND TEXTURE CHANGES

Pectin Breakdown and Hormonal Control:

1. **Pectin as a Structural Component:** Pectin, a complex polysaccharide, is a key structural component of plant cell walls. The softening of fruit tissues during ripening involves the controlled breakdown of pectin, a process regulated by various enzymes.
2. **Polygalacturonase and Pectinase Activity:** Enzymes such as polygalacturonase and pectinase play pivotal roles in catalyzing the hydrolysis of pectin. Their increased activity during ripening leads to the depolymerization of pectin molecules, contributing to the softening of fruit tissues.
3. **Hormonal Control of Enzyme Activity:** Hormones, particularly ethylene, exert control over the activity of enzymes involved in pectin breakdown. Ethylene regulates the expression of genes encoding these enzymes, influencing their production and activity during the ripening process.

Role of Ethylene in Texture Changes:

1. **Activation of Cell Wall-Modifying Enzymes:** Ethylene, the master regulator of fruit ripening, plays a central role in orchestrating texture changes. It activates cell wall-modifying enzymes, including those involved in the breakdown of hemicellulose and cellulose, contributing to the softening of fruit tissues.
2. **Starch to Sugar Conversion:** In some fruits, ethylene influences the conversion of starches to sugars, impacting both sweetness and texture. This transformation is particularly evident in climacteric fruits like bananas, where starches in the fruit are broken down into sugars during ripening, affecting both taste and texture.
3. **Cross-Talk with Other Hormones:** Ethylene engages in cross-talk with other hormones, such as auxins and gibberellins, to coordinate texture changes. While ethylene primarily promotes softening, the interactions with other hormones ensure a balanced and controlled process, preventing over-softening and maintaining the structural integrity of the fruit.

POST-HARVEST MANAGEMENT

Hormonal Treatments for Extended Shelf Life

1. **Ethylene Inhibitors:** Post-harvest management often involves the use of hormonal treatments to extend the shelf life of fruits. Ethylene inhibitors, such as 1-MCP (1-methylcyclopropene), can be applied to slow down the effects of ethylene on ripening. This treatment delays the onset of ripening processes, including softening and color changes, allowing for a longer storage period.
2. **Ethylene Application:** Conversely, controlled ethylene application can be used to synchronize and accelerate the ripening of fruits. This is particularly beneficial for fruits that are harvested before

reaching full maturity. Controlled exposure to ethylene post-harvest ensures uniform ripening, enhancing marketability.

3. **Cytokinin Application:** Cytokinins, known for their role in cell division, can be applied post-harvest to promote cell division and tissue regeneration. This treatment can help maintain firmness and improve the overall quality of fruits during storage.

Effective post-harvest management through hormonal treatments not only extends the shelf life of fruits but also contributes to reducing food loss and waste. By fine-tuning hormonal applications, horticulturists and post-harvest managers can enhance the market value of fruits and ensure a sustainable and efficient supply chain from harvest to consumption.

Table: PGR Application for Fruit Development and Maturation

Crop	PGR	Growth Period	Application Method	Time of Application	Purpose
Apple	Auxin (NAA)	Fruit set	Foliar spray	Post-bloom	Increase fruit set and prevent fruit drop
Grape	Gibberellin (GA3)	Early fruit set	Bunch dip	Before flowering	Increase berry size and reduce seed number
Tomato	Cytokinin (CPPU)	Fruit set and early growth	Foliar spray	During flowering	Increase fruit set and early fruit growth
Banana	Ethylene	Ripening	Gas release	Pre-harvest	Initiate and synchronize ripening
Citrus	Abscisic acid (ABA)	Pre-harvest	Foliar spray	4-6 weeks before harvest	Delay ripening and reduce fruit drop
Strawberry	Gibberellin (GA3)	Runner development	Foliar spray	After flowering	Promote runner growth and increase yield potential
Cherry	Auxin (NAA)	Fruit growth	Foliar spray	2-4 weeks after fruit set	Increase fruit size and improve fruit quality
Mango	Ethylene	Ripening	Gas release or ethephon application	Pre-harvest	Control ripening timing and improve fruit quality

CONCLUSION

In conclusion, the journey from flower to ripe fruit involves a sophisticated interplay of plant hormones. Auxins, cytokinins, gibberellins, ABA, and ethylene collectively regulate key processes like cell elongation, division, ripening initiation, and texture changes. The synergistic collaboration of these hormones ensures the balanced and harmonious development of fruits. Environmental factors further modulate hormonal responses, impacting fruit size and shape. The post-harvest realm introduces hormonal treatments, like ethylene inhibitors and cytokinin applications, enhancing shelf life and minimizing food loss. An in-depth understanding of hormonal dynamics is crucial for optimizing fruit production, quality, and post-harvest management strategies.

REFERENCES

Taiz, L., & Zeiger, E. (2017). *Plant Physiology (Fifth Edition).*. Sinauer Associates, Inc. (This comprehensive textbook delves into the intricate world of plant hormones, including their roles in fruit development and ripening.)

Davies, P. J. (2013). Plant hormones: Their role in plant growth and development. *Biotechnology and Genetic Engineering Reviews*, *29*(1), 1-14. (This review article provides a concise overview of the diverse functions of plant hormones, including their involvement in fruit set, growth, and ripening.)

Sexton, R., & Roberts, J. A. (1983). Role of hormones in fruit ripening. *Plant Physiology*, *72*(4), 1219-1222. (This classic paper explores the key role of ethylene in triggering the cascade of biochemical changes that occur during fruit ripening.)

Grossmann, K., & Wang, X. Q. (2011). Auxin-cytokinin interactions in the control of flower development. *Plant & Cell Physiology*, *52*(8), 1200-1211. (This article sheds light on the delicate interplay between auxin and cytokinin in regulating fruit set and early fruit growth.)

Gillaspy, G. (2000). Gibberellin signaling in plants. *Current Opinion in Plant Biology*, *3*(5), 386-391. (This review article highlights the multifaceted roles of gibberellins in fruit development, from influencing seed number and size to promoting cell elongation.)

Jia, H., Zheng, X., Yang, Y., Li, L., & Li, T. (2017). Abscisic acid signaling pathway and its modulation during fruit ripening. *Frontiers in Plant Science*, *8*, 896. (This article delves into the complex relationship between ABA and fruit ripening, exploring its dual role in promoting early fruit development and triggering late-stage ripening processes.)

Mochizuki, N., & Went, F. W. (1957). The role of ethylene in the flowering of pineapple. *Plant Physiology*, *32*(3), 349-357. (This historical paper highlights the pioneering work on ethylene's role in fruit ripening, using pineapple as a model system.)

Bai, J., & Ouyang, X. (2020). The role of ethylene in anthocyanin biosynthesis and the regulation of fruit color. *Plant Communications*, *1*(4), 100046. (This article explores the intricate link between ethylene and the vibrant colors of fruits, focusing on its influence on anthocyanin biosynthesis.)

How to Cite:

Pandey, A. and Bahadur, V. (2024). Role of plant hormones in controlling fruit development and maturation. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):35-44.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

ZESTFUL INGENUITY: UNLEASHING THE HIDDEN POTENTIAL OF CITRUS PEELS IN A WORLD OF CULINARY AND SUSTAINABLE WONDERS

Ishani Sharma[1*], Shiv Kumar Shivandu[1], Abhilash Padhan[1] and Ritik chawla[1]

[1]Department of Fruit Science, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India, 173230

*Corresponding author email: ishanisharma33.97@gmail.com

ABSTRACT

Citrus fruits, part of the Rutaceae family, include orange, tangerine, lime, lemon, sour orange, and grapefruit. Apart from their culinary use, they contribute significantly to processing industries, yielding products like marmalade, jams, juice, and jellies. However, this processing generates substantial peel and seed waste, raising environmental concerns. Efforts to minimize waste impact involve transforming it into candies, unlocking nutritional benefits. The bitterness of citrus peels poses a challenge, affecting demand. Despite global research exploring ways to utilize these discarded elements, considerable untapped potential remains. This article synthesizes international research, shedding light on the underexplored possibilities of citrus waste and strategies for optimizing its utilization.

INTRODUCTION

Citrus, a globally esteemed fruit crop, is rich in essential phytochemicals that contributes towards human health. Despite its nutritional richness, citrus peel, containing abundant antioxidants and vitamin C, often faces wasteful disposal, adding to the staggering annual global discard of 144 million metric tons of peel waste. These peels encompass not only the vibrant outer layer (epicarp) but also the softer inner layer (mesocarp), both repositories of polyphenols, essential oils, and compounds like auraptene and bergamottin, known for their health-enhancing properties (fig.1). The management of citrus waste presents intricate challenges, particularly in countries such as India. Here, the escalating waste production strains landfill capacities due to population growth and industrialization. Globally, approximately 30–40% of fruit and vegetable production goes to waste, influenced by factors like household sizes, income disparities, and inadequate waste management systems.

Addressing waste challenges involves initiatives to recycle and extract optimal value. Current waste management falls short, leading to environmental degradation, exacerbated by overflowing landfills due to household organic waste. Urgent intervention is needed to rectify disposal practices, especially indiscriminate dumping. One solution is producing eco-enzymes from fruit and vegetable waste, transforming organic matter into versatile products. Scaling up eco-enzyme production is crucial for efficiently managing rising waste volumes. Embracing a zero-waste framework advocates for reduction, reuse, and recycling, fostering a circular system. Citrus waste utilization in various sectors is crucial, from animal feed to eco-friendly solvents and antibiotics production (fig. 2). Proper utilization reduces environmental impact and generates renewable bio-based products, emphasizing the need for effective waste management. However, optimizing citrus waste utilization not only addresses environmental challenges but also yields valuable bio-based products, emphasizing the urgent need for efficient waste management strategies.

BIOACTIVE AND NUTRITIONAL COMPOSITION

Discarded citrus components, including peel, seeds, juice vesicles, and membrane, represent a substantial and economically valuable source of high-added-value compounds such as dietary fibre, flavonoids, polyphenols, sugars, carotenoids, ascorbic acids, and essential oils. These citrus wastes, with their elevated sugar levels, prove crucial for processes like fermentation in bioethanol production and serve as substrates for solid-state fermentation (Khan *et al.*, 2021) (Table 1).

Table 1 Different bio-active compound and their benefits of citrus based products

Bioactive compound(S)	Potential benefits/uses	Citrus based sources
Dietary fibre	Integral in diet, lowers disease risk (cardiovascular, diabetic), aids weight loss, reduces hypertension, prevents heart disease.	Pulp and peel
Phenolics	Phenolics: potent antioxidants prevent cancer, tumors, and shield cells from free radical damage traditionally.	Peel and pulp
Essential oils.	Acts as a commercial antimicrobial agent, preserving food by inhibiting deterioration, possessing antifungal, insecticidal, antibacterial properties.	Peel
Carotenoids.	Vital in animal feed, nutraceuticals, pharmaceuticals, and as colorants in foods and cosmetic products.	Peel and pulp
Pectin	Pectin stabilizes and gels food, prevents poisoning, and aids diabetes and reflux.	Peel

BY-PRODUCT UTILIZATION

The primary challenge in citrus production is harshness, prompting analysts to explore by-product utilization, specifically rind and seeds, to improve overall citrus utilization. The major processing by-products, including all citrus fruits, peel, and pomace, constitute 55-60 per cent of the fresh fruit. These by-products serve various purposes, acting as insecticides, fumigants, and insect pest repellents. They also play major roles in recovering and purifying volatile oil and seed oil, processing pelletized dry peels as cattle feed, and repurposing citrus peel (Table 2).

Table 2 Potential health, economic and environmental benefits from citrus by-product utilization

Utilizing citrus by product as	**Potential health, economic and environmental benefits**
Dietary fibre	Citrus fruits, rich in both soluble (gum, pectin) and insoluble (lignin, cellulose, hemicellulose) dietary fibre, inhibit meat lipid oxidation, extending shelf life. Orange juice fibre, sourced from seeds, pulp, and peel, acts as a fat substitute in ice cream, thanks to its outstanding oil and water retention. These resistant polysaccharides provide unique health benefits and aid digestion.
Pectin production	Citrus rind contains pectin, a soluble fibre widely used in jams, jellies, medications, and juices as a gelling agent. Pectin's versatility extends to eco-friendly food packaging as edible films, showcasing biocompatibility and biodegradability. Extracted from citrus, it acts as a stabilizing, thickening agent in various products, from baked goods to confectionery.
Peel utilization	About 30-34% of fruit peel becomes a significant byproduct during citrus juice processing. This peel waste is repurposed for extracting polyphenolic compounds, creating value-added products known for their potential as sources of phenolic blends with beneficial antioxidant and antimicrobial properties. Peel Powder: The powder, obtained by drying kinnow rind through mechanical and solar methods, meets standard parameters. Candied Peel: Achieving the best colour and desirable caramelized appearance, candies are prepared by cooking at 70 degrees Celsius for 25 minutes in a syrup solution of 60 degrees brix (Rafiq *et al.*, 2018).

Seed oil	Citrus seeds and peels stand out as valuable sources for oils with diverse applications. The extracted seed oil, boasting 98.6% carboxylic acid and abundant tocopherols like alpha and gamma-tocopherols, features essential fatty acids such as palmitic and linoleic acids. With attributes like an iodine number of 104.80 g I/100 g of oil, a refractive index of 1.465 at 40°C, and a specific gravity of 0.927 mg/ml at 25°C, this oil finds utility in ear drops, disinfectants, and medicinal formulations for respiratory diseases.
Repellent	The volatile oil extracted from citrus waste serves as an insect repellent. However, the precise mechanisms behind repellents in various arthropods remain uncertain and even contradictory within scientific literature. Monounsaturated fatty acid and linoleic acid have been shown to trigger death aversion in cockroaches, leading to the suggestion of a 'necromone' as the compound responsible for this behaviour.
Insecticide and fumigant	Volatile oils from well-known sources like lime, sweet orange, and lemon exhibit insecticidal or repellent properties. Understanding their mechanisms is crucial for effective insect control, but practical large-scale application faces challenges due to the physical properties of volatile oils.
Biofuel production	Citrus fruit waste, rich in soluble and insoluble carbohydrate polymers, holds promise for biofuel conversion like biogas and ethanol. Anaerobic digestion with mesophilic bacteria offers an affordable means to produce methane from orange peel pressing liquid and citrus waste. Commercial-scale anaerobic reactors present an eco-friendly solution for processing stored waste with lower environmental impact and operational costs than treating fresh citrus waste.
Animal feed	Citrus processing waste, a valuable by-product, finds utilization in animal feed industries due to its abundant bioactive compounds, acting as a nutritious supplement while preventing the growth of harmful bacteria like salmonella and Escherichia coli. These waste materials offer a rich source of structural fibre, delivering essential nutrients for animal production, maintenance, growth, and reproduction.
Eco-enzyme	Eco-enzymes, derived from fruit peels, brown sugar, and water, serve as potent

	cleaning agents. The choice of raw materials significantly influences eco-enzyme production, aiming to reduce landfill waste while creating economic value. This eco-friendly liquid finds multiple uses from waste treatment to air purification and biopesticide/fertilizer roles after three-month fermentation.
Disinfectant	With a pH of 4 and a citrus aroma, it's an excellent disinfectant (Benny et al., 2023). By utilizing fruit peels instead of chemicals, these disinfectants align with eco-friendly practices, fostering waste reduction and recycling at the household level. This collective effort helps diminish waste until reaching near-zero levels.

FUTURE PROSPECTIVE

Citrus processing waste, abundant in plant-derived natural supplements, is positioned to substitute synthetic additives in the food industry. The increasing awareness of its health benefits is expected to propel the demand for natural ingredients, especially in food, cosmetics, and pharmaceuticals. The functional compounds present in this waste will experience heightened utilization across diverse sectors, contributing to the production of value-added chemicals. By harnessing citrus waste, not only is environmental damage mitigated, but waste accumulation is also reduced, signalling a shift towards prioritizing resource utilization over disposal.

CONCLUSION

Citrus waste, encompassing wastewater and peels, is crucial in the pharmaceutical, cosmetic, and food industries. Effectively managing this waste offers economic gains by enriching the soil as a natural conditioner and animal feed. Loaded with bioactive compounds, it combats inflammation, infections, and thrombosis for better health outcomes. However, disposal poses environmental and economic challenges. Utilizing citrus pulp as an adsorbent material effectively purifies industrial effluents. Our strong advocacy can end citrus waste disposal, promoting awareness of its diverse benefits. This strategy curtails waste accumulation, encourages healthier practices, and reduces reliance on synthetic products, promising multifaceted benefits for health and the environment.

REFERENCES

Benny, N., Shams, R., Dash, K. K., Pandey, V. K., & Bashir, O. (2023). Recent trends in utilization of citrus fruits in production of eco-enzyme. *Journal of Agriculture and Food Research*, 100657.

Kaur, H., & Singh, G. (2021). Recent trends in citrus (citrus spp.) Peel utilization: a review. *Plant Archives (09725210)*, *21*(1).

Khan, U. M., Sameen, A., Aadil, R. M., Shahid, M., Sezen, S., Zarrabi, A., & Butnariu, M. (2021). Citrus genus and its waste utilization: a review on health-promoting activities and industrial application. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1-17.

Rafiq, S., Kaul, R., Sofi, S. A., Bashir, N., Nazir, F., & Nayik, G. A. (2018). Citrus peel as a source of functional ingredient: A review. *Journal of the Saudi Society of Agricultural Sciences*, *17*(4), 351-358.

Varmie, E. B., & Thakur, M. (2021). Utilization of citrus processing waste: A review. *Pharma. Innov. J*, *10*, 682-697.

How to Cite:

Sharma, I., Shivandu, S.K., Padhan, A., and Chawla, R. (2024). Zestful ingenuity: unleashing the hidden potential of citrus peels in a world of culinary and sustainable wonders. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):45-50.

*********XXXXX**********

MITIGATING HEAT STRESS: BEST PRACTICES FOR POULTRY WELL-BEING

Ithrineni Karthik*, Asok Kumar M, Faslu Rahman A.T and Avantika Srivastav

Division of Pathology, ICAR-IVRI, Bareilly, U.P. 243122

Corresponding author: drkarthik0807@gmail.com

ABSTRACT

Elevated ambient temperatures significantly contribute to economic losses in the poultry sector due to heat stress (HS). HS adversely affects poultry farming, impacting production performance, body temperature regulation, intestinal health, appetite hormones, immune responses, and oxidative characteristics. Timely monitoring of these parameters is crucial for early detection of heat stress, facilitating interventions to minimize its adverse effects. While conventional strategies involve feed supplements and management practices, outcomes vary. This article explores the physiological repercussions of HS on poultry health and production, delving into diverse management and nutritional approaches to effectively cope with the challenges posed by heat stress in the poultry industry.

INTRODUCTION

The poultry industry, a cornerstone of global food production, faces a persistent and formidable challenge in the form of heat stress. As a multifaceted and dynamic phenomenon, heat stress profoundly influences the physiological well-being, productivity and overall health of poultry species (Awad *et al.*, 2019). Elevated ambient temperatures, particularly prevalent in tropical and arid regions, pose a considerable threat, leading to economic losses and necessitating a comprehensive understanding of its intricate consequences. Heat stress (HS) results from an imbalance between the energy released and produced within the system. The impact of Heat stress is accentuated by relative humidity, making the temperature-humidity index (THI) a crucial instrument for determining the optimal temperature conditions for bird rearing (Barrett et al., 2019).

The well-established understanding is that elevated energy expenditure for maintenance leads to heat stress in poultry flocks. This condition detrimentally impacts various aspects of poultry, including productive and reproductive performance, economic traits, and overall welfare. When birds experience 10-20 times increase in respiration rates due to heat stress, there is an elevated loss of CO_2 through the lungs. This heightened CO_2 loss contributes to an increase in blood pH, leading to a disruption in the acid-base balance, which, in turn, adversely affects both the health and performance of the birds (Abbas *et al.*, 2012). Acute heat stress can occur during sudden and brief periods of excessively high ambient temperatures and humidity. On the other hand, chronic heat stress results from prolonged exposure to elevated ambient temperatures coupled with increased humidity (Scanes, 2015).

ADVERSE CONSEQUENCES OF HEAT STRESS ON CHICKENS

Elevated temperatures represent a significant stress factor in poultry farming. The primary consequence of heat stress is a decline in feed intake, resulting in diminished body weight and reduced egg production. Metabolic responses play a crucial role in these physiological changes. Chickens, lacking sweat glands, encounter challenges in dissipating heat from their bodies to the environment and rely on panting as the primary mechanism for releasing excess body heat.

1) IMPACT OF HEAT STRESS ON THE PERFORMANCE OF POULTRY

The standard body temperature for a chicken is around 41°C (106°F); exceeding a temperature increase of more than 4°C can result in the death of the bird. Heat stress in poultry flocks is often induced by summer weather and elevated environmental temperatures. Birds experience 'heat stress' when they struggle to maintain equilibrium between the production and loss of body heat (Scanes, 2015).

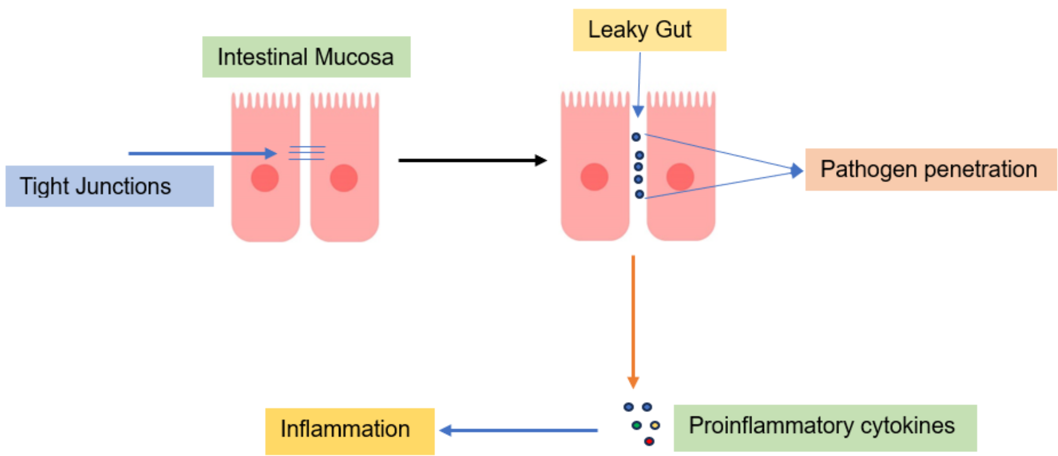
Birds experience optimal comfort at 75°F, and their normal functioning extends smoothly up to 80°F (Donald and William, 2002). Beyond 80°F (up to 85°F), there is a decline in feed consumption, accompanied by an increase in water intake. This shift in environmental conditions results in reduced feed conversion ratios (FCRs) and weight gain in broiler birds, while layer and breeder flocks witness a decline in egg production (Donald and William, 2002). Moreover, noticeable signs of depression, nervous behaviours, and manifestations such as trembling, staggering, and convulsions may also be observed. Body weight gain, egg production, egg size, egg quality, hatchability and fertility are decreased in breeder flocks and decreased weight gain, dressing percentage in broilers, exposed to heat stress (Sahin *et al.*, 2018).

2) EFFECT OF HEAT STRESS ON THE HEALTH OF POULTRY:

Heat stress causes a substantial increase in water consumption and metabolic rate of poultry but decreased feed intake contributes to the occurrence of watery droppings and diarrhoea, leading to a notable decline in body weight. Broilers in the production phase are inherently prone to heat stress due to existing stress factors (Lara and Rostagno, 2013). During this stage, there is an elevation in respiration, an increase in gular fluttering, and a rise in CO2 levels, impacting the central nervous system (CNS) and leading to convulsions and mortality. Birds experiencing heat stress exhibit elevated heterophil/lymphocyte ratios and increased levels of liver enzymes in their serum (Abbas et al., 2017), potentially correlating with heightened mortality rates. Furthermore, heat stress diminishes the weight of lymphoid organs and reduces antibody concentrations in the serum.

A robust immune system is essential for optimizing production outcomes, given its direct correlation with the health of chickens. Major immune organs, including the thymus, bursa of Fabricius and spleen, were observed to undergo a decline during HS in chickens (Quinteiro-Filho *et al.*, 2010). The heightened intestinal permeability associated with HS facilitates the entry of pathogens through the gastrointestinal tract. This leads to an increase in the prevalence of pathogenic bacteria such as Salmonella sp., Clostridium sp., and Escherichia coli, consequently impairing immune function in heat-stressed chickens.

Heat stress has detrimental effects on intestinal permeability and integrity by causing alterations in the morphology of the intestines and compromising the intactness of epithelial junctions which leads to "leaky gut syndrome" (Galarza-Seeber *et al.*, 2016).



STRATEGIES TO AMELIORATE HEAT STRESS IN POULTRY

The persistent rise in global environmental temperatures underscores the necessity for employing diverse strategies to mitigate the effects of heat stress (HS). Various approaches have been attempted, albeit with limited success, and are elaborated upon below:

1) MANAGEMENT PRACTICES:

- **House Design**: Poultry facilities should be meticulously planned to prevent the infiltration of external heat. Optimal insulation is essential to uphold the internal temperature of poultry houses. In regions with high temperatures, it is recommended to orient the poultry sheds from east to west in length and north to south in width. Facilitating natural airflow from the north and south sides while shielding birds from excessive sunlight is advisable, emphasizing the need for the shed's longitudinal direction to be from east to west. Particularly crucial is the insulation of the roof, given that 60% of external heat enters the house through the ceiling (Scanes, 2015). To mitigate high temperatures and low humidity in poultry farming, evaporative cooling systems can be implemented. This involves the use of cooling pads inside the shed, complemented by the use of sprinklers on farms (Tumova and Gous, 2012).

- **Feeding management:** Implementing fasting for broilers before or during the peak hot periods of the day serves to reduce the heat load and improves survival rates. It is advisable to conduct feeding during the cooler hours of the day, specifically in the early morning and late evening (Farghly et al., 2018a). Fasting results in a reduction of heat production associated with the processes of digestion, absorption, and nutrient metabolism. Additionally, fasting induces a calming effect on the birds. In tropical environments, particularly during the rainy season, wet feeding has proven advantageous in alleviating heat stress. This feeding method enhances feed consumption, leading to improved Feed Conversion Ratio (FCR) in meat-type strains.
- **Water management:** Birds experiencing heat stress tend to reduce their feed intake while increasing water consumption**.** Ensuring the stable body temperature of birds requires providing unrestricted access to clean and cool water below 25°C, with the flexibility to incorporate ice into the water. Vital measures to prevent dehydration during heat stress involve augmenting the number of drinkers, ensuring sufficient space, and maintaining an uninterrupted water supply, as emphasized by Abbas et al. in 2008.
- **Litter management:** In warm weather, litter temperature rises. To prevent this, maintain the litter moderately wet. Excessively dry litter causes heat and low humidity, while overly wet litter indicates high humidity. Dried wet litter forms cakes, leading to a bad smell and ammonia production, impacting bird growth, attracting flies, and inducing stress (Bessei, 2006).
- **Health management:** Instituting robust biosecurity measures is imperative to prevent the spread of diseases within the flock. Heat stress can exacerbate the susceptibility of broilers to various pathogens, making biosecurity practices even more critical during periods of elevated temperatures. Strict control of visitor access, proper sanitation practices, and regular health checks contribute to maintaining a disease-free environment (Donald and William, 2002). Adding probiotics to bird diets can enhance microbial diversity in the jejunum and caecum, reinstating a balanced microbial environment and preserving natural stability.

2) NUTRITIONAL MANAGEMENT:

Mitigating heat stress in poultry requires careful consideration of their nutritional requirements. Adequate nutrition plays a crucial role in helping birds cope with high temperatures and maintain optimal health and performance. Here are key nutritional strategies to alleviate heat stress in poultry:

- **Antioxidant Supplementation**: High ambient temperatures pose a significant risk of oxidative stress. Organic salts of minerals exhibit antioxidant properties, inhibiting the formation of free radicals and subsequently reducing oxidative stress. Studies have demonstrated the amelioration of heat stress (HS) effects in embryos from dams fed organic selenium by elevating the glutathione-glutathione peroxidase (GSH-GPX) system. Zinc is crucial in suppressing free radicals as it acts as a cofactor (Cu/Zn-SOD) and inhibits NADPH-dependent lipid peroxidation (Sahin *et al.*, 2009).
- **Amino Acid Balance**: Amino acids are essential for protein synthesis, which is vital for maintaining muscle function and overall health. During heat stress, optimizing amino acid balance in the diet becomes crucial to support protein synthesis and minimize muscle breakdown. Ensuring sufficient essential amino acids, particularly lysine or a combination of arginine and lysine, and incorporating 2-hydroxy-4-(methylthio) butanoic acid (HMB) into the diet can be advantageous (Suganya *et al.*, 2015).
- **Vitamin Supplementation**: Heat stress can affect the metabolism of certain vitamins. Providing Vitamin C in feed or water helps regulate bird body temperatures. Its addition reduces corticosterone levels during heat stress, improving immune response, feed consumption, oxidative stress, and overall carcass quality and weight. Adding vitamin E to the diet mitigates the negative impact of stress hormones. Vitamin E acts to safeguard lymphocytes, macrophages, and plasma cells from oxidative damage, thereby enhancing the immune response (Sahin *et al.*, 2009).
- **Probiotics and Prebiotics**: Probiotics, which are beneficial bacteria, and prebiotics, which promote the growth of these bacteria, contribute to a healthy gut microbiota. Maintaining a balanced gut microbiome is essential for nutrient absorption, immune function, and overall gut health during heat stress.
- **Electrolyte therapy**: Electrolyte therapy is essential for maintaining salt balance, especially during heat stress. Addressing imbalances in the acid-base equilibrium, supplementing with potassium chloride at 0.2-0.5%, proves beneficial in sustaining osmotic and acid-base balance while also promoting increased water consumption. Dietary supplementation with salts like potassium bicarbonate, sodium chloride, potassium chloride, and ammonium chloride has been shown to enhance water consumption in heat-stressed birds Khattack *et al.*, 2012).

CONCLUSION

The rising global temperatures, coupled with a decline in heat tolerance among modern poultry genotypes, have become a significant worry for poultry farmers. The challenges posed by heat stress have detrimental effects on various aspects of poultry farming, including growth, meat quality and quantity, laying rates, and egg quality standards. Consequently, these impacts contribute to substantial economic losses in poultry production. Numerous strategies have been implemented to counteract the severe repercussions of heat stress (HS). Opting for rearing systems that enhance ventilation, maintaining suitable housing conditions, and adhering to recommended stocking densities are crucial factors in improving performance in elevated ambient temperatures. Additionally, supplementing the diet with various additives like vitamins, minerals, probiotics, and bioactive compounds has proven effective in mitigating the adverse effects of HS.

REFERENCES

Abbas G., Mahmood S., Nawaz, H., 2017. Effect of dietary inclusion of sodium bicarbonate on blood profile of caged layers during summer. *Pakistan Journal Agriculture Sciences* 54,2

Abbas, A., Khan, M.J., Naeem, M., Ayaz, M., Sufyan, A., Somro, M.H., 2012. Cation anion balance in avian diet:(a Review). *Agriculture Science Research Journal*.

Abbas, A.O., El-Dein, A.A., Desoky, A.A., Galal, M.A., 2008. The effects of 629 photoperiod programs on broiler chicken performance and immune 630 response. *International Journal Poultry Science* 7, 665-671.

Awad, E. A., Najaa, M., Zulaikha, Z. A., Zulkifli, I., & Soleimani, A. F. (2019). Effects of heat stress on growth performance, selected physiological and immunological parameters, caecal microflora, and meat quality in two broiler strains. *Asian-Australasian Journal of Animal Sciences*, 33(5), 778–787. https://doi.org/10.5713/ajas.19.0208

Barrett, N. W., Rowland, K., Schmidt, C. J., Lamont, S. J., Rothschild, M. F., Ashwell, C. M., & Persia, M. E. (2019). Effects of acute and chronic heat stress on the performance, egg quality, body temperature, and blood gas parameters of laying hens. *Poultry Science*, 98(12), 6684–6692. https://doi.org/10.3382/ps/pez541

Bessei, W., 2006. Welfare of broilers: a review. *World's Poultry Science Journal* 62(3),455-466

Donald, D.B., William, D.W., 2002. Commercial Chicken Meat and Egg Production, 6 th 888 Edition, Online ISBN 978-1-4615-0811-3, Kluwer Academic Publishers

Farghly, M.F.A., Alagawany, M., Abd El-Hack, M.E., 2018a. Feeding time can 918 alleviate negative effects of heat stress on performance, meat quality and health status of turkey. *Britain Poultry Science* 59, 205-210.

Galarza-Seeber, R., Latorre, J. D., Bielke, L. R., Kuttappan, V. A., Wolfenden, A. D., Hernandez-Velasco, X., & Tellez, G. (2016). Leaky gut and mycotoxins: Aflatoxin B1 does not increase gut permeability in broiler chickens. *Frontiers in Veterinary Science*, 3, 10. https:// doi.org/10.3389/fvets.2016.00010.

Khattak, F.M., Acamovic, T., Sparks, N., Pasha, T.N., Hussain, M.H., Joiya, M., Ali, Z., 2012. Comparative efficacy of different supplements used to reduce heat stress in broilers. *Pakistan Journal of Zoology* 44, 31.

Lara, L.J., Rostagno, M.H., 2013. Impact of heat stress on poultry production. *Animals*. 3, 356-369.

Quinteiro-Filho, W. M., Ribeiro, A., Ferraz-de-Paula, V., Pinheiro, M. L., Sakai, M., Sa, L. R., & Palermo-Neto, J. (2010). Heat stress impairs performance parameters, induces intestinal injury, and decreases macrophage activity in broiler chickens. *Poultry Science*, 89(9), 1905–1914. https://doi.org/10.3382/ps.2010-00812.

Sahin, N., Hayirli, A., Orhan, C., Tuzcu, M., Komorowski, J.R., Sahin, K., 2018. Effects of the supplemental chromium form on performance and metabolic profile in laying hens exposed to heat stress. *Poultry Science* 97(4), pp.1298-1305.

Sahin, N., Tuzcu, M., Ozercan, I., Sahin, K., Prasad, A. S., & Kucuk, O. (2009). Zinc picolinate in the prevention of leiomyoma in Japanese quail. *Journal of Medicinal Food*, 12(6), 1368–1374. https://doi. org/10.1089/jmf.2008.0287

Scanes, C.G., 2015. Sturkie's Avian Physiology (Sixth Edition). Chapter 37 –Regulation of Body Temperature: Strategies and Mechanisms. Academic Press USA. 869–905.

Suganya, T., Senthilkumar, S., Deepa, K., Amutha, R., 2015. Nutritional management to alleviate heat stress in broilers. *International Journal Science Environment Technology* 4,661 – 666.

Tumová, E., Gous, R.M., 2012. Interaction of hen production type, age and temperature on laying pattern and egg quality. *Poultry Science* 91,1269– 1457 1275.

How to Cite:

Ithrineni, K., Asok Kumar M, Faslu Rahman A.T and Srivastav, A. (2024). Mitigating heat stress: best practices for poultry well-being. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World*, 4(2):51-58.

*********XXXXX**********

www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 2 FEBRUARY, 2024

THE ADVANTAGES OF BIOACTIVE PHYTOCHEMICALS IN INDIAN FOOD FOR HEALTH AND THEIR ROLE IN DISEASE PREVENTION

Soniya Ashok Ranveer
Maharashtra Animal and Fishery Sciences University, Nagpur
*Corresponding author email: soniyaranveer11@gmail.com

ABSTRACT

This article explores the pivotal role of nutrients, phytochemicals, and antioxidants in promoting health and preventing diseases. From historical nutrient studies to the recent surge in interest in phytochemicals, the article delves into the multifaceted aspects of nutrition. Emphasis is placed on functional foods and the disease-preventing potential of dietary fiber. Antioxidants, including carotenoids and flavonoids, are examined for their epidemiological impact on cancer and cardiovascular diseases. Additionally, the article elucidates the detoxifying functions of food phytochemicals and the inhibitory roles of blocking and suppressing agents in carcinogenesis. A comprehensive overview of phytosterols, phytonutrients, and their immunological significance is presented, emphasizing the need for precise dietary intake to combat non-communicable diseases.

INTRODUCTION

Studies since the mid-19th century have focused on identifying essential nutrients in foods, their metabolism and functions and dietary deficiency. Food technology and food processing have focused on conserving these nutrients in processed foods as well as researching human requirements of these nutrients and strategies to combat nutritional deficiency diseases among underprivileged population groups. Foods, particularly those of plant origin, contain a wide range of non-nutrient phytochemicals that are elaborated by plants for their own defence and other biological functions.

PHYTOCHEMICALS IN PLANT FOODS

Many plants and herbs are considered to have medicinal value, and their phytochemicals present in commonly consumed plant foods are normally non-toxic and have the potential to prevent chronic diseases. For the last two to three decades, there has been a surge of interest in plant foods as a source of phytochemicals that may have a useful role in the prevention of chronic diseases such as cancer, diabetes, cardiovascular disease, cataract, and gallstone. Functional foods, which are foods derived from naturally occurring substances, provide health benefits beyond basic nutrition and have been studied extensively to establish their efficacy and understand the underlying mechanism of their action.

Several nutrients like vitamin E, provitamin A, ascorbic acid, and selenium also have disease-preventing and health-promoting potentials, just like phytochemicals. Research on the health-promoting and disease-preventing potential of phytochemicals in foods has grown so much in recent years that this branch of research has been named bionutrition.

DIETARY FIBER AND NON-STARCH POLYSACCHARIDES

Dietary fibre (DF) and non-starch polysaccharides (NSP) are essential components of plant foods, which have been shown to reduce blood glucose levels in diabetes, lower blood cholesterol levels for cardiovascular disease treatment, and prevent bowel cancer. The disease-preventing potential of DF depends on the proportion and quantity of different polysaccharide components present in a given food. DF components exert their beneficial effects mostly through swelling properties and increasing transit time in the small intestine, reducing the rate of glucose release and absorption. They also bind bile salts, promoting cholesterol excretion from the body and reducing blood cholesterol levels. They can also have adverse nutritional effects by binding dietary calcium, magnesium, zinc, and iron, reducing their bioavailability. Dietary fibre intake in India is generally recommended to be around 40 g for an adult, with diets based predominantly on unrefined cereals and plant foods easily achieving this level. Dietary fiber intake in India varies from 60 to 70 g/day, depending on the type of cereal consumed. Nearly 80% of the fiber content of diets consumed in India, particularly among the low-income group, is contributed by cereals.

ANTIOXIDANTS IN DISEASE PREVENTION:

Antioxidants play a crucial role in disease prevention, as reactive oxygen species, cause tissue damage and contribute to various diseases. The body has protective mechanisms against dangerous oxygen free radical species generated in situ and those derived from external sources, such as superoxide dismutase, glutathione reductase, and selenium. Foods contain a variety of antioxidants, both nutritive and nonnutritive, including carotenoids, phenols, and flavonoids. Plant foods, such as green leafy vegetables, fruits, and yellow vegetables, are rich in these antioxidants. Vitamin C and vitamin E prevent carcinogenic formation, while flavonoids and phenolic compounds protect selenium and polyunsaturated fatty acids from oxidative damage. However, the potency of antioxidants in vivo depends on their bioavailability and oxidant levels in the food.

EPIDEMIOLOGICAL RESEARCH ON ANTIOXIDANT PHYTOCHEMICALS:

Dietary antioxidant phytochemicals including carotenoids, phenolic compounds, and flavonoids may prevent cancer and cardiovascular disease, according to epidemiological research. Elevated levels of blood carotenoids, such as lutein, zeaxanthin, and lycopene, have been associated with a reduced risk of lung cancer. Regular intake of flavonoids, such as quercetin and kaemferol, by the elderly reduces the risk of death from coronary heart disease. In conclusion, antioxidants and antioxidant-rich foods have been shown to have a beneficial impact on the prevention and treatment of non-communicable diseases, such as cancer.

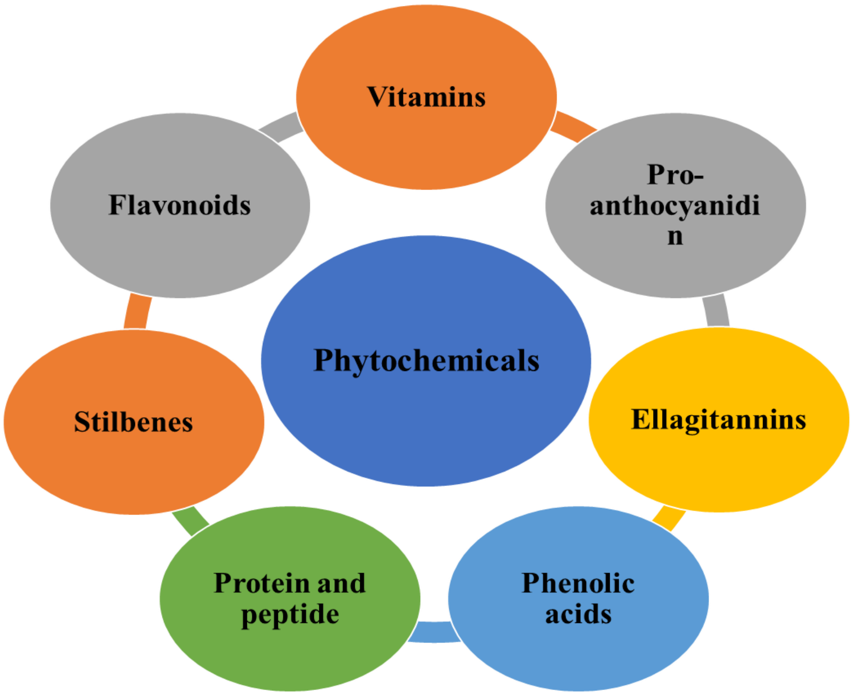


Fig: Digestion and bioavailability of bioactive phytochemicals

Food phytochemicals eliminate chemical toxicants and carcinogens, preventing disease. They remove toxins through phase I and phase II metabolism. Phase I metabolism involves oxygenation, oxidation, reduction, and dehydrogenation; phase II involves conjugation. Many phytochemicals in food are nontoxic xenobiotics that stimulate phase I metabolic enzymes. Toxicity from carcinogen exposure depends on phase I and phase II enzyme balance. Strong inducers of MFO include safrole, xanthenes, flavones, and indoles. Coumarin derivatives in fruits and vegetables can induce glutathione-S-transferase and inhibit chemical carcinogenesis. Crucifera vegetables include indole derivatives such indole-3 acetic acid and isothiocyanates, which induce phase II drug metabolism enzymes and are anticarcinogenic.

BLOCKING AND SUPPRESSING AGENTS IN CARCINOGENESIS

Several minor chemical constituents of foods inhibit carcinogenesis by acting as blocking and suppressing agents. Blocking agents enhance metabolic disposal of carcinogens and prevent active carcinogens from reaching the target tissue or cell. Suppressing agents inhibit carcinogenesis at the cellular level, and compounds with antioxidant properties can also inhibit the formation of carcinogens from their precursors. Neuropharmacological chemicals in foods, such as 5-hydroxy tryptamine, noradrenaline, tyramine, and dopamine, are present in small quantities in foods like bananas, annanas, tomatoes, avocados, and spices. These biogenic amines' pharmacological and physiological effects are unknown. Ancient medicine believed certain meals improved brain function, learning, and conduct and sharpened mental agility. Studies on malnourished children have linked anaemia, PEM, and vitamin A deficiencies to brain, mental, and learning impairment.

PHYTOSTEROLS AND PHYTONUTRIENTS

Phytosterols, such as stigmasterol, sitosterol, and campesterol, are widely distributed in the plant kingdom and in plant foods. These plant sterols have hypocholesterolaemic potential and have been shown to have a positive effect on both humoral and cell-mediated immune function. Vitamin C and carotenoids may have beneficial effects on immune function, reducing cancer risk by enhancing tumor control. Phytonutrients in plant foods contain a wide range of chemical compounds that impart taste and flavor to food. Most foods, particularly fruits, vegetables, and spices, contain very small quantities of volatile compounds, which may have beneficial biological functions in the body.

Desirable dietary intake of phytonutrients is needed to provide maximal protection against non-communicable diseases like diabetes, cancer, cardiovascular disease, and cataract. Precision quantitative data on the content of phytochemicals in commonly consumed foods and their bioavailability and biological potency is needed to formulate special diets for preventing specific diseases.

CONCLUSION

This comprehensive exploration underscores the significance of nutrition in disease prevention and health promotion. The interplay of nutrients, phytochemicals, and antioxidants in functional foods demonstrates promising avenues for combating ailments such as cancer and cardiovascular diseases. Understanding the delicate balance of blocking and suppressing agents in carcinogenesis sheds light on potential preventive measures. Moreover, the immunological impact of phytosterols and phytonutrients signifies their crucial role in fostering overall well-being. As we advance, precision in quantifying and harnessing these nutritional elements becomes paramount for formulating targeted diets, offering a proactive approach against prevalent non-communicable diseases.

How to Cite:

Soniya, A. T. (2024). The advantages of bioactive phytochemicals in Indian food for health and their role in disease prevention. Leaves and Dew Publication, New Delhi 110059. Agri Journal World, 4(2):59-63.

*********XXXXX**********