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From the Editor's

Dear Readers,

In the March issue of our Newsletter, we received several popular articles from diverse fields. All the authors deserve great appreciation for sharing articles in huge numbers. Please continue sending articles to our Publication team and share published newsletter with your friends also.

I would like to thank the Editorial team including Print, Designer and Publication committee for their efforts throughout the edition.

Your suggestions are always welcomed for improvement.

Dr. R. S. Tomar
Editor-in-Chief

ADVANCEMENTS IN CRISPR TECHNOLOGY: REVOLUTIONIZING CROP IMPROVEMENT FOR SUSTAINABLE AGRICULTURE

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Introduction

Climate change and the increasing demand for food security due to the world's population growth solely represent two of the many issues facing in the global agriculture sector. Traditional farming methods, which mostly rely on chemical inputs and require a lot of land, are often unsustainable. In recent years, a revolutionary tool that has the potential to completely change crop breeding in recent years is CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats). CRISPR allows for precise genetic modifications (at nucleotide level) in plants, opening new avenues for sustainable crop improvement. This article explores the latest developments in CRISPR technology and how they are transforming agriculture to adapt to the needs of the changing global environment.

What is CRISPR and How Does it Work?

CRISPR is a naturally occurring defense mechanism found in bacteria, where it functions to recognize and cut viral DNA. In recent years, scientists have harnessed this system for gene editing in various organisms, including plants. The key components of CRISPR include the Cas9 enzyme, which acts as molecular scissors to cut DNA at specific locations, and a guide RNA, which directs Cas9 to the target sequence (Fig. 1).

The precision and efficiency of CRISPR technology have made it a game-changer in genome editing field. Unlike traditional genetic modification, which involves inserting genes from unrelated species, CRISPR allows for targeted changes in a existing plant's genome, enabling scientists to either activate or deactivate specific genes without introducing foreign DNA.

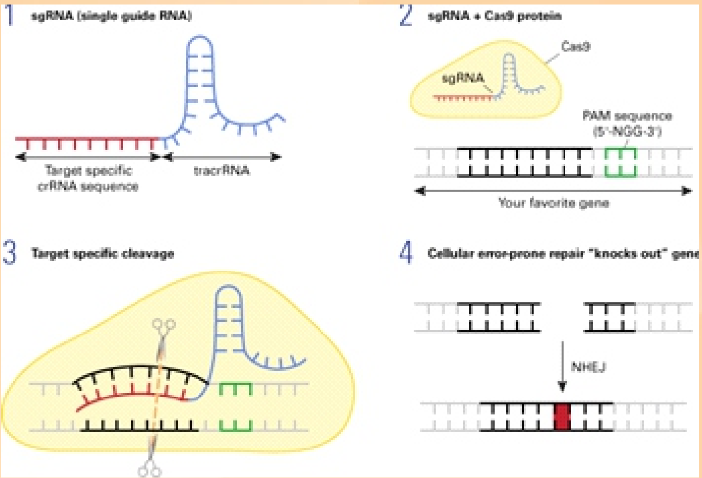

Figure 1: CRISPR components and it's mechanism.

Key Advancements in CRISPR for Crop Improvement

1. Enhancing Crop Yield and Disease Resistance

CRISPR has been successfully used to develop crops with higher yields and enhanced resistance to diseases. For instance, a breakthrough in CRISPR technology has led to the development of rice strains with increased resistance to bacterial blight, a major crop disease that significantly affects rice production worldwide. By knocking out a gene that allows the bacteria to infect the rice plant, researchers have been able to create plants that are naturally more resistant to this pathogen (Zhou *et al.*, 2019).

Similarly, CRISPR has been employed to enhance resistance to fungal diseases, such as wheat blast, by editing genes that control plant defense mechanisms. This approach not only reduces the need for chemical pesticides but also supports more sustainable farming practices.

2. Improving Drought and Salinity Tolerance

With climate change exacerbating extreme weather events, including droughts and floods, crops that can thrive in harsh environmental conditions are becoming increasingly important. CRISPR technology has enabled the development of drought-tolerant crops by editing genes involved in water retention and stress response. For example, researchers have used CRISPR to modify the wheat genome to increase the expression of genes related to drought tolerance, potentially enabling crops to grow in arid regions (Zhang *et al.*, 2020).

Additionally, CRISPR has been used to engineer salt-tolerant plants. By editing genes associated with ion transport and osmotic regulation, researchers have created crops that can grow in saline soils, which are becoming more prevalent due to rising sea levels and poor irrigation practices (Zhu *et al.*, 2020). This innovation holds the potential to expand arable land and improve food security in regions with challenging environmental conditions.

3. Improving Nutritional Content

CRISPR has also made it possible to enhance the nutritional profile of crops, addressing malnutrition in developing countries. One of the most notable examples is the development of "Golden Rice," which has been genetically engineered to produce higher levels of pro-vitamin A (beta-carotene) to combat vitamin A deficiency in populations with limited access to diverse diets. While Golden Rice was initially developed using traditional genetic modification, CRISPR techniques have since been applied to further refine its genome for greater efficiency and precision.

CRISPR has also been used to improve the nutritional content of other crops, such as soybeans and potatoes, by increasing the levels of essential amino acids, vitamins, and antioxidants. These advancements have the potential to improve the overall health of populations worldwide, especially in regions where diverse food sources are scarce.

4. Reducing Environmental Impact and Pesticide Use

One of the most significant advantages of CRISPR in agriculture is its potential to reduce the environmental impact of farming. By creating crops that are naturally resistant to pests and diseases, CRISPR can help reduce the need for chemical pesticides, which often have harmful effects on ecosystems and human health. For instance, researchers have used CRISPR to create mosquitoes that are resistant to the transmission of malaria, a concept that could potentially be applied to agricultural pests. Similarly, CRISPR-edited crops that resist herbicides or insect infestations could reduce the reliance on toxic chemicals.
In addition, CRISPR can also help optimize the use of fertilizers by editing plant genes to improve nutrient uptake efficiency, thereby reducing the environmental pollution caused by excessive fertilizer use.

Ethical Considerations and Regulatory Challenges

Despite its promising potential, CRISPR technology in agriculture raises several ethical and regulatory concerns. Critics argue that gene editing in crops, particularly the release of genetically modified organisms (GMOs) into the environment, may have unintended ecological consequences. The long-term effects on biodiversity, gene flow, and ecosystems remain uncertain and require further investigation.

Furthermore, there is ongoing debate about how CRISPR-edited crops should be regulated. In many countries, crops modified using traditional genetic engineering techniques are subject to strict regulatory frameworks, while CRISPR-edited crops may fall into a gray area. Some countries, such as the United States, have adopted more lenient regulations for gene-edited crops, while others, such as the European Union, maintain stricter controls. The establishment of clear, science-based regulatory guidelines is essential to ensure the safe and responsible use of CRISPR in agriculture.

Conclusion

CRISPR technology represents a major leap forward in agricultural biotechnology, offering the potential to enhance crop yields, improve resistance to diseases, and enable sustainable farming practices in the face of climate change. From improving drought tolerance to enhancing nutritional content, CRISPR holds immense promise for addressing global food security challenges. However, as with any emerging technology, it is essential to proceed with caution, considering the ethical and ecological implications of gene editing in agriculture. As research continues and regulatory frameworks evolve, CRISPR has the potential to play a pivotal role in the future of sustainable agriculture.

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ELECTRIC FIELD-BASED TECHNOLOGY IN FOOD AND AGRICULTURE

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Electric field-based technologies are emerging as powerful tools in food processing and agriculture, offering non-thermal, energy-efficient, and eco-friendly solutions. These technologies utilize controlled electric fields to improve food preservation, microbial inactivation, crop growth, and pest management. The most common electric field-based methods include pulsed electric fields (PEF), ohmic heating, electroporation, and plasma-assisted treatments. Electric field-based treatments in food and agriculture include various innovative techniques such as pulsed electric fields (PEF), ohmic heating, electroporation, dielectric heating, and cold plasma treatment. PEF involves short, high-voltage pulses that inactivate microbes in food without heat, preserving nutrients and extending shelf life. Ohmic heating generates heat within food by passing an electric current through it, enabling fast and uniform cooking or sterilization. Electroporation enhances the permeability of cell membranes, improving the extraction of juices, essential oils, and bioactive compounds. Dielectric heating (microwave and radiofrequency heating) uses alternating electric fields to heat food rapidly, aiding in drying and pasteurization. Cold plasma treatment produces reactive species that eliminate bacteria, fungi, and pests, making it useful for food decontamination and crop protection. These electric field-based techniques are revolutionizing food processing and sustainable agriculture by improving efficiency, reducing chemical usage, and enhancing product quality.

Applications in Food Processing

1. Pulsed Electric Fields (PEF) for Food Preservation

PEF involves the application of short, high-voltage electric pulses to food products, which disrupts microbial cell membranes, leading to pathogen inactivation without heat. It is widely used for:

- Extending the shelf life of fruit juices, dairy, and liquid foods.
- Enhancing the quality of fresh-cut vegetables and meats.

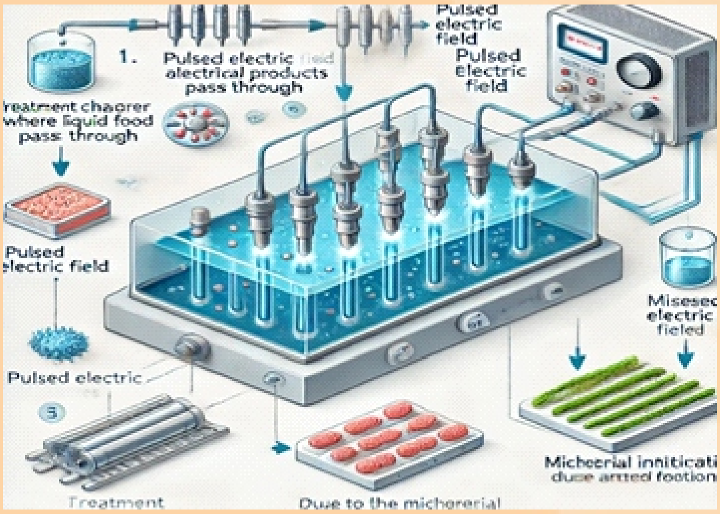

Fig 1.: Schematic representation of Pulsed Electric Fields technique.

2. Ohmic Heating for Pasteurization and Cooking

Ohmic heating applies an electric current directly through food, generating uniform heat and reducing processing time. It helps in:

- Sterilization of liquid foods like soups and dairy.
- Minimizing nutrient loss compared to traditional thermal pasteurization.

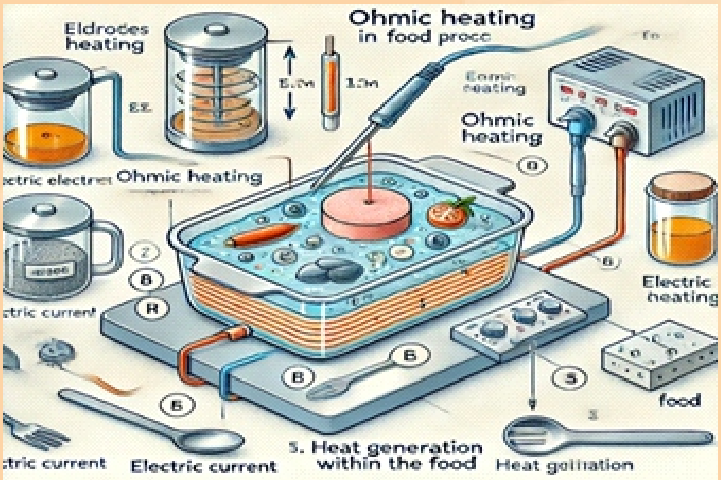

Fig 2: Schematic representation of Ohmic heating technique.

3. Electroporation for Nutrient Extraction

Electroporation increases the permeability of cell membranes, making it easier to extract juices, essential oils, and bioactive compounds from fruits, vegetables, and herbs. This method is:

- More efficient than conventional methods, requiring less energy and solvents.
- Used for enhancing fermentation and improving winemaking.

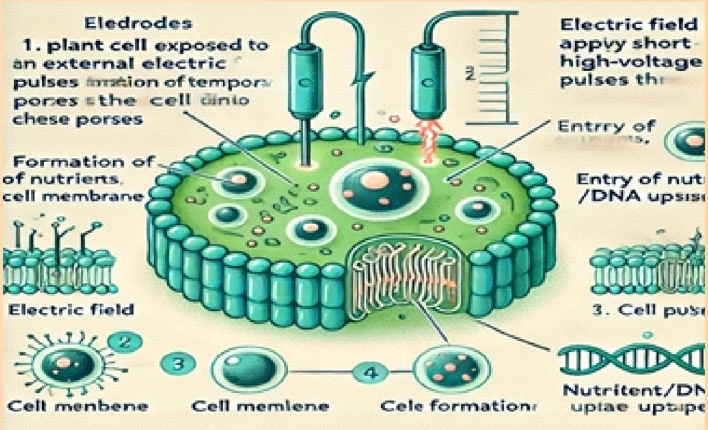

Fig 3: Schematic representation of electroporation technique.

Applications in Agriculture

1. Electric Fields for Seed Germination and Growth

- Low-intensity electric fields stimulate enzyme activity and root development, leading to higher germination rates and better crop yields.
- Improves nutrient absorption in plants, leading to faster growth.

2. Pest and Disease Control

- Plasma-assisted treatments generate reactive species that kill pathogens and pests without harming crops.
- Electric fields disrupt insect nervous systems, reducing infestations naturally.

3. Soil and Water Treatment

- Electric fields help in removing contaminants from irrigation water.
- Improve soil aeration and nutrient availability, enhancing crop productivity.

4. Post-Harvest Processing

- Electric field-assisted drying preserves food with minimal energy consumption.
- Used in grain storage to prevent mold growth.

Conclusion

Electric field-based technologies are revolutionizing food preservation, agricultural productivity, and sustainability. They offer chemical-free, energy-efficient alternatives for enhancing food quality and crop yields while reducing environmental impact. As research advances, these techniques will play a crucial role in smart farming and modern food processing.

THE BEE APOCALYPSE

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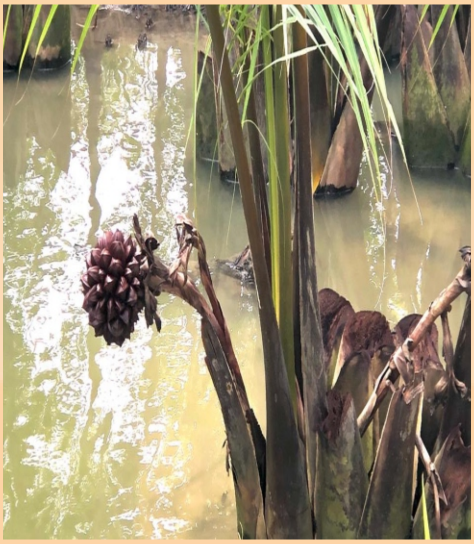
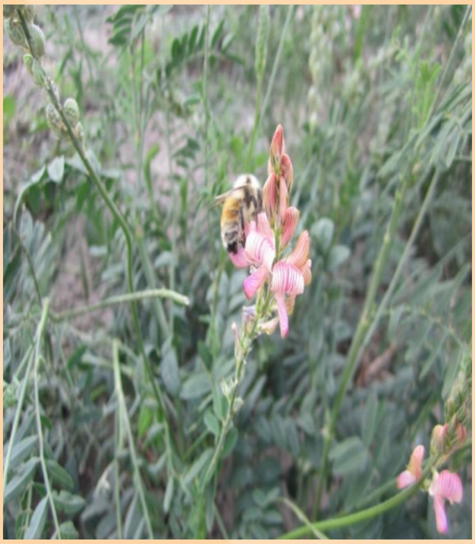
Abstract: Bees and other insect pollinators like moths and butterflies, flies and beetles contributing to natural pollination are globally showing an alarming decline due to a number of anthropogenic factors. Bees (both honey bees and native/wild bees) are important natural pollinators and essential for the survival of our global agriculture, forestry and apiculture industries. Among factors impacting global be decline are extensive and indiscriminate use of synthetic chemical pesticides as well as fertilizers, pollution, lack of proper bee foraging vegetation (melliferous flora) for collecting nectar and pollen, reduced immunity and rise in pest infestations of bee and bee hives and other infectious diseases, Colony Collapse Disorder (CCD), change in land use patterns, Global Warming abs Climate Change to mention only a few. Hence it is absolutely important to conserve and protect highly vulnerable pollinator insects like bees that has been worst impacted. The bees have now been designated as the most important animal species on the entire planet. All kinds of bees are suffering but the worst impact is on our native/wild bees. Honey bees can still be replaced as they are produced commercially, but there is no commercial





production of native bees to replace the one we are rapidly losing. Contrary to our common perception that all bees make hives it actually not true. Several native bee species survive in nest within holes made in the soil. The irrigation water with huge surface run off carrying all kinds of residual insect pesticides and synthetic chemical fertilizers

percolate down the soil killing entire critically endangered bee colonies along with the Queen bee. Around 95-99% native bee populations have decreased the past two decades. Particularly seed canola and seed alfalfa are heavily dependent on pollinators like bees for maintaining their yield. Bees are primary pollinators are integrated with agriculture, forestry and apiculture industries that employ several millions of people around the planet irrespective developed and developing or under developed nations. Unless great emphasis is laid upon bee conservation, the current insect apocalypse may wipe out both bees and humanity from our planet. We need to think about sustainable solutions towards helping economy and ecology to work hand in hand.

Photo credit: **Saikat Kumar Basu**

WHEATGRASS: A MIRACULOUS MICROGREEN

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Introduction:

Microgreens are the natural boon to mankind, owing to their tremendous health benefits. The microgreens are referred to as the next generation of "superfoods" as they possess a wide array of health-promoting phytonutrients, including varied macro and micro nutrients such as protein, carbohydrates, vitamins, antioxidants, enzymes, bioflavonoids, phenolic compounds along with several minerals like iron, calcium, magnesium, phosphorus, potassium, sodium, zinc and numerous additional health-promoting substances. Microgreens are young and tender, edible nutrient-dense seedlings that are harvested after the cotyledonary leaves have fully developed and the first true leaves emerge. Wheatgrass is a promising microgreen also called as the powerhouse of varied nutrients essential for the human body. Wheatgrass (*Triticum aestivum*) is a cereal grass of the family Poaceae, is the world's most cultivated and edible cereal grass crop (Fig.1). The bioefficacy of wheatgrass is conferred by the presence of its bioactives such as abscisic acid, chlorophyll a, chlorophyll b, chlorophyllin, epigenin, rutin, ferulic acid, gallic acid, caffeic acid, syringic acid and p-coumaric acid are the major ones. Wheatgrass possesses several pharmacological properties *viz.*, anti-aging, anti-cancer, anti-ulcer, anti-diabetic, anti-allergic, anti-microbial, antioxidant, anti-inflammatory, anti-arthritic and prebiotic potentiality. Therefore, the wheatgrass is considered as a wonderful curative nutraceutical for healthy lifestyle.

Kingdom	**Plantae**
Division	Magnoliophyta
Class	Liliopsida
Order	Cyperales
Family	Poaceae
Genus	Triticum
Species	aestivum

Fig. 1: Pictorial Presentation and Classification of Wheatgrass

Cultivation of Wheatgrass:

The superior quality of wheat was procured, and cleaned properly. The wheat grains after soaking for 12 h in water were knotted in wet woven cotton cloth and hung for a period of 12 h for sprouting. Water was sprinkled over the cotton cloth at least thrice during germination period. After 12 h of germination, the germinated wheat was sowed in a shady place. A small amount of water was sprinkled and 3-4 h of indirect sunlight were permitted each day to promote wheatgrass growth and prevent excessive nutrient loss from direct sunlight exposure. Since wheat can grow in all temperatures, shady place is preferred to avoid excess nutrient loss due to exposure to direct sunlight. The sown grains began to develop, and the grass was harvested after 7-9 days (Fig. 2). At this point, wheatgrass is at its nutritious peak.

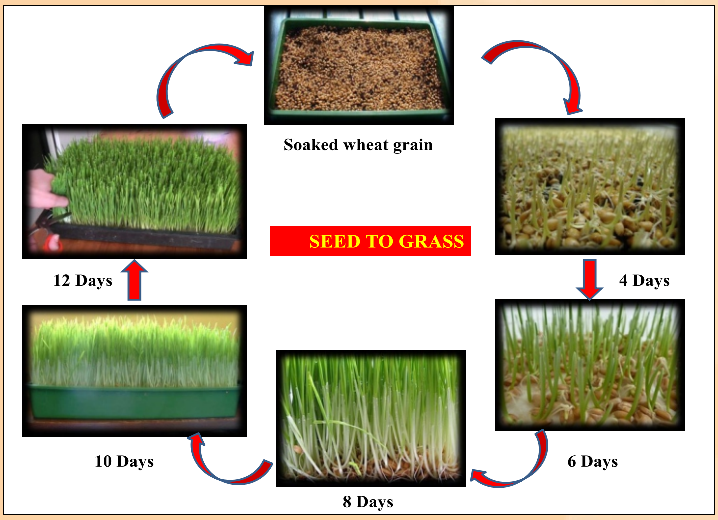

Fig. 2: Pictorial Presentation of Wheatgrass Cultivation.

Nutritional Profile of Wheatgrass:

1. **Protein:** Wheatgrass juice is an excellent source of protein; it contains 17 amino acids among them ten essential amino acids and eight non-essential amino acids.
2. **Essential amino acid:** Methionine, Isoleucine, Leucine, Arginine, Histidine, Lysine, Phenylalanine, Threonine, Tryptophan and Valine.
3. **Non-essential amino acid:** Aspartic acid, Asparagine, Glutamine, Proline, Glycine, Alanine, Tyrosine and Serine.
4. **Carbohydrate:** Muco-polyscharrides.
5. **Vitamins:** Beta-carotene, Thiamine, Riboflavin, Niacin, Pantothenic Acid, Pyridoxine, Cobalamin, Ascorbic acid, Tocopherol and Phylloquinone.
6. **Minerals:** Macro minerals: Calcium, Phosphorus, Sulphur, Magnesium, Sodium, Potassium and Chlorine.
7. **Micro minerals:** Iron, Zinc, Copper, Iodine, Aluminum, Selenium, Boron, Molybdenum and Alkaline earth metal.
8. **Bioactive compounds:** Flavonoids, Chlorophyll,

Chlorophyllin, Apigenin. Quercetin, Rutin, Indole, Choline, Laetrile, Saponins, Tannins, Alkaloids, Glycosides, Phytosterols and Triterpenoid.

9. **Enzymes:** Superoxide Dismutase (SOD), Cytochrome Oxidase, Transhydrogenase, Lipase, Amylase and Protease.

Extraction and Structural Elucidation of Bioactives: The extraction of wheatgrass and the structural elucidation of the bioactive compounds from wheatgrass by high-performance liquid chromatography (HPLC) are presented in Fig. 3.

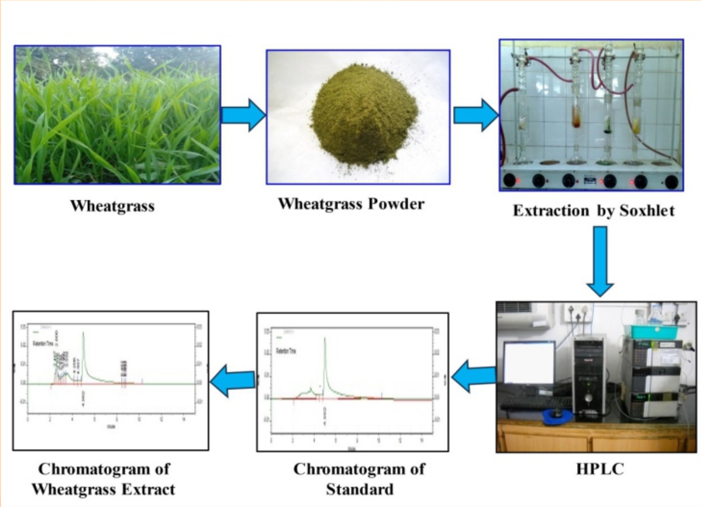

Fig. 3: Wheatgrass Extraction and Identification of Bioactive Compounds.

Health Benefits of Wheatgrass:
Wheatgrass possesses several potential pharmacological properties. The health promoting activities of wheatgrass as curatives against several ailments are presented in Fig. 4.

Fig. 4: Pharmacological Activity of Wheatgrass.

Conclusion:
Wheatgrass, a miracle microgreen, is a rich source of varied nutrients possessing potential health promoting vigor. Microgreens have gained prominence over the recent decades, with implications across the global healthcare system. Therefore, incorporating wheatgrass as an integral part of the daily diet enhances the nutritional level and elevate the health status of the individual. In a nutshell, the wheatgrass is a potential storehouse of several nutrients along with bioactive compounds conferring immense potential health benefits. However, very little scientific and clinical studies have been conducted on the use of wheatgrass in several ailments. Therefore, it is the need of the hour to conduct extensive research on the bio-efficacy of wheatgrass which will pave the path for novel drug discovery in years to come.

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Editorial board members of NESA newsletter will be revised for the year 2025. All the interested applicants may send their curriculum vitae to **Editor in Chief** by **25th March, 2025.**

MEMBERS ARE REQUESTED TO PLEASE PLANT ONE PLANT/TREE IN YOUR NEIGHBOURHOOD ON YOUR BIRTHDAY AND SEND US SMALL BRIEF WITH PHOTOGRAPH OF THE PLANTATION OF PLANT / TREE SO WE CAN PUBLISH IN OUR NESA NEWSLETTER.

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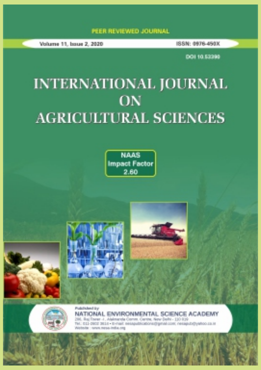

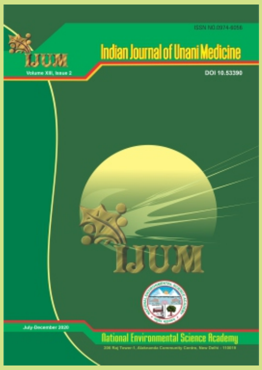

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