ONLY NEWS PAPER PUBLISHED IN INDIA FOR SCIENTIFIC COMMUNITIES

NESA NEWSLETTER

NATIONAL ENVIRONMENTAL SCIENCE ACADEMY

Vol. 27 Issue-11 (MONTHLY) November 2024

From the Editor's

Dear Readers,

In the November 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 welcome for improvement.

Dr. R. S. Tomar
Editor-in-Chief
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DIVERSITY OF RICE IN FORMS OF DIFFERENT CULTIVARS

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Rice (*Oryza sativa* L.) has many cultivars across its range of distribution due to a combination of ecological, cultural, and genetic factors that have contributed to its diversity over time. Here's why:

1. **Wide Ecological Adaptation:** Rice is cultivated in diverse environments, from tropical lowlands to high-altitude terraces. This has led to the development of cultivars adapted to specific climatic, soil, and water conditions, such as drought-resistant varieties for arid regions or flood-tolerant varieties for wetlands.

2. **Human Selection and Domestication:** Rice has been domesticated for thousands of years, with humans selecting plants for traits like yield, taste, aroma, cooking quality, and resilience to pests or diseases. This has resulted in numerous region-specific cultivars tailored to local preferences and agricultural needs.

3. **Cultural and Culinary Preferences:** Different cultures have developed preferences for particular types of rice, such as long-grain (e.g., Basmati), short-grain (e.g., Japonica), or aromatic varieties. These culinary preferences have driven the diversification of rice.

4. **Geographical Barriers and Isolation:** Geographic isolation of rice-growing regions has allowed distinct genetic lineages to evolve. For example, Indica and Japonica rice represent two major subspecies with distinct genetic and phenotypic traits.

5. **Breeding and Hybridization:** Advances in agricultural science have led to the development of new cultivars through breeding programs. These programs often combine desirable traits from different rice varieties to create hybrids with higher yields, better disease resistance, or climate adaptability.

6. **Mutation and Natural Selection:** Natural genetic mutations over time, combined with environmental

pressures, have contributed to the diversity of rice cultivars. Some mutations result in traits that provide a selective advantage in certain conditions.

7. **Global Distribution:** As rice spread across the world through trade and migration, it encountered new environments and cultural influences, which further promoted diversification. Examples of cultivar diversity includes flood-tolerant rice varieties like Swarna Sub1 can survive underwater for extended periods. Varieties like Jasmine and Basmati are prized for their fragrance as aromatic rice. Sticky rice is used in East and Southeast Asia, especially for desserts and traditional dishes. This adaptability and diversity make rice a staple food for more than half of the world's population.

The wide diversity of rice cultivars signifies both the adaptability of rice as a crop and its critical role in human culture, nutrition, and food security. Here's what it means for us as humans:

1. **Adaptation to Diverse Environments**
   The diversity of rice cultivars reflects the ability of rice to thrive in a variety of climates, soils, and ecosystems—from high-altitude terraces to floodplains. This adaptability ensures that rice can be cultivated in nearly every corner of the world, making it a staple food for over half the global population.

2. **Food Security and Resilience**
   Having a broad genetic pool of rice varieties strengthens global food security. It enables breeders to develop cultivars that are resistant to pests, diseases, droughts, or floods. This is especially crucial in the face of climate change, which poses significant risks to agriculture.

3. **Nutritional and Culinary Diversity**
   Different rice cultivars vary in taste, texture, and nutritional content. Some, like brown or red rice, are rich in fiber and antioxidants, while others, like jasmine or basmati, are prized for their aromatic qualities. This diversity caters to regional dietary preferences and nutritional needs.

4. **Cultural and Economic Importance**
   Rice diversity reflects the cultural heritage of different communities. Varieties unique to specific regions are often tied to traditions, rituals, and cuisines. Economically, it provides livelihoods for millions of farmers, especially in Asia, Africa, and Latin America.

5. **Conservation of Biodiversity**
   The wide range of cultivars highlights the importance of conserving agricultural biodiversity. Traditional varieties, often maintained by smallholder farmers, hold genetic traits that might be essential for future breeding programs and ecological sustainability.

In essence, the diversity of rice cultivars ensures not only our physical sustenance but also the preservation of cultural traditions, ecological stability, and our ability to face agricultural challenges in the future.

Rice cultivars hold significant ecological and economic importance globally due to their role in food security, environmental sustainability, and economic development. Below are the key points:

Ecological Importance

Biodiversity:
Rice paddies support a variety of ecosystems, providing habitats for aquatic species, birds, and beneficial insects. Maintaining diverse rice cultivars helps conserve genetic biodiversity essential for resilience to pests, diseases, and climate change.

Carbon Sequestration:
Rice fields can contribute to carbon sequestration, as flooded paddies store organic matter in soil. However,

managing water levels can mitigate methane emissions, a greenhouse gas associated with rice cultivation.

Water Management:
Traditional rice cultivation methods like flooded paddies help recharge groundwater and manage hydrological cycles in certain regions.

Soil Fertility:
Rice cultivation systems, particularly in rotation with other crops, improve soil fertility by integrating nitrogen-fixing plants and organic matter recycling.

Climate Adaptation:
Rice varieties adapted to extreme conditions (e.g., drought-tolerant, saline-resistant cultivars) are essential for maintaining agricultural productivity in changing climates.

Economic Importance

Food Security:
Rice is a staple food for more than half of the world's population, particularly in Asia, Africa, and Latin America. Its cultivation ensures caloric and nutritional intake for billions.

Employment and Livelihoods:
The rice industry supports the livelihoods of millions of farmers, laborers, and small-scale entrepreneurs in both rural and urban settings.

Economic Contribution:
Rice is a significant export commodity for many countries (e.g., India, Thailand, Vietnam), generating foreign exchange and contributing to national economies.

Value-Added Products:
Rice by-products like bran, husk, and straw are used in industries such as bioenergy, animal feed, cosmetics, and pharmaceuticals, adding economic value.

Cultural and Culinary Significance:
Rice plays a central role in cultural traditions, festivals, and cuisines in many countries, indirectly promoting tourism and trade.

Technological Innovation:
Investment in the development of high-yielding and stress-tolerant rice cultivars drives agricultural innovation and global research collaboration.

Interlinking Importance
Rice cultivars bridge the gap between ecological sustainability and economic stability. For example, sustainable rice farming practices, like the System of Rice Intensification (SRI), reduce resource use (water, fertilizer) while increasing yields, benefiting farmers economically and reducing environmental impacts.

Rice cultivars are vital to addressing global challenges related to food security, rural livelihoods, and sustainable environmental practices, making them indispensable in both ecological and economic contexts.

Photo credit: ***Saikat Kumar Basu***

MIGRATION OF FOOD PACKAGING MATERIAL

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Introduction
Food packaging is used for the preservation of food products, providing safety from contamination, and facilitating easy handling and transportation for consumers. Several packaging materials such as paper, glass, plastic, and metal cans, as well as earthen pots, are used for the packaging of food. Nowadays, consumers are very concerned about health awareness because these packaging materials can transfer harmful substances into the food. The major function of packaging materials is to protect and preserve the food quality from physical, chemical, and microbial spoilage (Alamri et al., 2021).

The widely used material in food packaging is plastic. It maintains the quality and enhances the shelf life of the product during storage. However, there is increased concern due to the potential release of undesirable components in food products. These plastics have migratory properties, affecting the quality of the products and posing health risks to consumers (Kan and Miller, 2022).

Packaging materials
The most widely used plastic materials for food packaging are polypropylene (PP), polyethylene (PE), polyvinyl chloride (PVC), polyamide (PA), polyethylene terephthalate (PET), low-density polyethylene (LDPE), high-density polyethylene (HDPE), and others. To improve the quality and properties of the end product, it is necessary to add additives such as antioxidants, colorants, UV

absorbers, lubricants, stabilizers, plasticizers, etc., to the packaging. Additionally, these packaging materials are often printed and coated (Hahladakis et al., 2018).

Migration in food packaging materials

Migration, the transfer of chemical compounds like volatile compounds, additives, and oligomers from packaging to food, poses a significant concern. These substances can originate from various sources in packaging materials, including plastic, paper, metal, and printing inks. Regulatory authorities have implemented laws to address contamination issues in food. Several factors affect the migration of packaging materials into food, such as food types, packaging polymers, physiochemical properties of the migrant, storage duration and temperature, and the package-to-food ratio (Alamri et al., 2021; Eti et al., 2023) . Polymeric materials are extensively utilized for food and beverage packaging. Despite its prevalence, it's vital to acknowledge that this packaging isn't inert and may harbor harmful chemicals capable of permeating the food. Consequently, regulatory bodies closely monitor its usage and harmful impacts. Chemical migration from packaging to food is influenced by diverse factors, encompassing the chemical and physical properties of the substances, as well as the characteristics of the food and packaging material. These factors include substance concentration, molecular weight, solubility, diffusion, partition coefficients, and the interaction between the packaging and the food product. Food packaging materials need to be carefully monitored because they pose health risks due to the materials used. The potential migration of carcinogenic chemical compounds into the food needs to be eliminated (Alamri et al., 2021).

The migration of compounds from food packaging materials is a significant concern. Plastic packaging often incorporates plasticizers to enhance flexibility and processing, with many belonging to the group of esters of phthalic acid and adipic acid, which can migrate from packages to foods. Antioxidants are used to prevent lipid oxidation caused by exposure of polymers to UV light and air; both natural antioxidants like vitamins A, C, and E, and synthetic ones such as butylated hydroxyanisole, butylated hydroxytoluene, and propyl gallate are utilized for this purpose. Metal packaging, including tin, lead, aluminium, and chromium, can pose risks due to migration into food. While tin coatings can prevent migration, lead, despite its toxicity, is still used in metal packaging and represents a significant contaminant. Aluminium, commonly used in food packaging, can corrode and migrate into food due to various alloy compositions. Chromium, utilized in tin layering for oxidation resistance and enamel adherence, can have carcinogenic effects. Glass packaging, though resistant to water and acidic chemicals, can experience migration, with silica and alkali being common migratory components. Low cost, light weight, availability, printability, and strength make paper and paper board products popular as food packaging materials around the world. However, the limitation of using paper and paper board as a food packaging material is the permeability to moisture which may facilitate the migration of unintended compounds from paper and board packaging into food items (Bandara and Indunil, 2022; Eti et al., 2023).

The migration of unintended chemicals from food packaging is affected by different parameters such as comparability and the nature of food, contact time, temperature, contacting layer of food packaging, food packaging compounds, food simulating liquids, and heating and storage conditions. It is necessary to avoid toxic materials and contaminants migration from paper or paper board food packaging or wrappings to food items as this may adversely influence consumer health. Paper packaging introduces dioxins, known for their high toxicity, and benzophenone, used as a photoinitiator, with potential carcinogenic and estrogenic effects, particularly when exposed to UV radiation during printing processes (Bandara and Indunil, 2022; Eti et al., 2023).

Testing of migration from food packaging materials

Migration testing involves determining the migration of compounds from packaging materials through water, ethanol, acetic acid, and oil. Several factors affect this migration, such as exposing the packaging material to food for specific times and temperatures. Water is used as an aqueous solution for determining the migration of packaging materials, while acetic acid serves a similar purpose. Ethanol is also utilized for this testing. Specific migration testing employs various instruments such as Liquid Chromatography Mass Spectrometry (LC-MS), Gas Chromatography Mass Spectrometry (GC-MS), and Infrared Spectroscopy (IR) to identify specific chemical compounds migrating from packaging materials to food (Kiyataka et al., 2015; Nguyen et al., 2023).

Conclusion

In conclusion, food packaging plays a vital role in preserving food products, ensuring safety from contamination, and facilitating convenient handling and transportation for consumers. Various packaging materials are employed, including plastic, paper, glass, metal, and earthen pots, each with its benefits and considerations. However, the increasing awareness of health risks associated with packaging materials, especially plastics, underscores the importance of stringent monitoring and regulation. Migration of chemical compounds from packaging materials into food presents significant concerns, necessitating thorough testing and adherence to regulatory standards. Trace metals, plasticizers, antioxidants, and other additives used in packaging require careful consideration to mitigate health risks. Migration testing methodologies, including exposure to water, ethanol, acetic acid, and oil, coupled with advanced analytical techniques like LC-MS, GC-MS, and IR spectroscopy, aid in assessing and controlling migration risks. Ultimately, ensuring the safety and quality of food packaging materials remains paramount in safeguarding consumer health and well-being.

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THE VULNERABLE FISHING CAT

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The fishing cat (*Prionailurus viverrinus*), the majestic state animal.of West Bengal faces a precarious future due to several threats, leading to concerns about its possible demise and the need for urgent conservation actions, including captive breeding programs. Fishing cats rely heavily on wetlands, mangroves, and swamps. Widespread destruction of these habitats due to urbanization, agriculture, and aquaculture has pushed this species to the brink. Wetland conversion for rice paddies and shrimp farming further reduces their living space.

Fishing cats often prey on fish in aquaculture ponds, leading to conflicts with local communities. Retaliatory killings are a significant concern. Fishing cats are hunted for their skin, meat, and as a perceived pest in fishing communities. Rising sea levels and extreme weather events threaten coastal mangrove ecosystems (e.g., Sundarbans), one of their strongholds. Fishing cats are naturally elusive and solitary, with sparse populations, making them particularly vulnerable to local extinctions.

Captive breeding programs could play a critical role in saving fishing cats by maintaining a viable gene pool to prevent genetic bottlenecks that occur due to dwindling wild populations. Studying behavior, reproduction, and dietary needs in controlled settings will help conservationists plan reintroduction strategies. Captive populations act as a “safety net” in case wild populations decline further or face extinction. Successful captive breeding can support reintroduction efforts in suitable, protected habitats. Zoos and breeding centers can educate the public about the importance of wetland conservation and the fishing cat's role in the ecosystem.

Several zoos globally are involved in fishing cat captive breeding programs. Community-based conservation to mitigate human-wildlife conflict can help in the lo g term survival of the species. Increas investment in captive breeding and reintroduction to strengthen wild populations. Without immediate intervention, including habitat preservation and captive breeding, the fishing cat faces a grim future, emphasizing the urgent need for coordinated conservation efforts.

RENEWABLE ENERGY

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The global reliance on fossil fuels has fuelled industrial growth for centuries but at a significant environmental and social cost. With rising carbon emissions, depleting reserves, and the looming threat of climate change, the world must transition to renewable energy sources. Solar, wind, hydro, geothermal, and biomass energy offer cleaner, sustainable alternatives that promise a brighter, greener future. Fossil fuels such as coal, oil, and natural gas have driven the global economy, but their drawbacks are undeniable. Burning these fuels emits large quantities of greenhouse gases, causing global warming, air pollution, and health hazards. Furthermore, fossil fuel extraction often results in severe ecological damage, including deforestation and water contamination. With reserves diminishing, the long-term availability of these energy sources is in question, making renewable energy a critical

necessity.
Fossil fuel is a universal term for non-renewable energy sources such as coal, coal products and derivatives, crude oil, and petroleum products which originated from plants and animals that existed millions of years ago. Fossil fuels have been the anchor of any industrial processing as an energy source due to their high efficiency and ease of use. However, the cons of fossil fuels outweigh the pros by being limited, exhaustible, expensive, and most importantly posing serious threats to our environment by causing various forms of pollution, including air, water, soil, noise, etc, which can in turn even cause drastic climatic changes.

Renewable sources of energy include solar, wind, geothermal, hydroelectric, and biomass which if harnessed to their full potential with the proper use of technology, can be the most ideal solution to all the problems created by the overuse of fossil fuels. Unlike fossil fuels, renewable energy sources are much safer for the environment as they don't emit harmful gases or pollutants that are hazardous for the life forms of our planet and also reduce global warming to a

significant extent.
Global demand for primary energy rises by 1.3% each year to 2040, with an increasing demand for energy services as a consequence of the global economic growth, the increase in the population, and advances in technology. In this sense, fossil fuels (oil, natural gas, and coal) have been widely used for energy production and are projected to remain the dominant energy source until at least 2050. The use of fossil fuels for energy production or chemicals results in the emission of greenhouse gases, such as carbon dioxide, nitrogen oxides, and other volatile compounds, and solid particles into the atmosphere, contributing to global climate change. On the basis of the foregoing, multiple studies have focused on developing new technologies toward renewable energy sources as an alternative to fossil fuels.

The rapid development of technology over the past few decades has contributed greatly to utilising the untapped potential of renewable energy sources. Solar power can be used in the form of electrical energy by installing solar panels and photovoltaic cells on the roofs of houses and industries. Similarly, wind energy and hydroelectric energy can be rendered useful by the installation of windmills and dams respectively. Geothermal energy and biomass energy are developing with time and hold vast potential as bio fuels, a cleaner and sustainable alternative, that can be manufactured by utilising biomass to its full extent. Even though there are several benefits of renewable energy sources, there are various challenges faced while utilising them to the maximum extent. Lack of space, proper infrastructure, initial capital, and awareness can hinder the utilisation process.

The Government, industries, and environmental activists should work together to bring down these problems. Imposing certain limits such as carbon footprint, providing suitable funding for building the infrastructures as well as encouraging the research and development sector by providing necessary funds and incentives and spreading mass awareness about the benefits, would help in facilitating the adoption of renewable energy by the industries of various fields such as manufacture of equipment, railway, automobile, mining, textile, etc. The transformation from fossil fuels to renewable sources plays a major role in not only preserving the environment but also developing the social and economic sectors. The challenges of transition can be overcome by the collective efforts of every individual, leading to a greener planet.

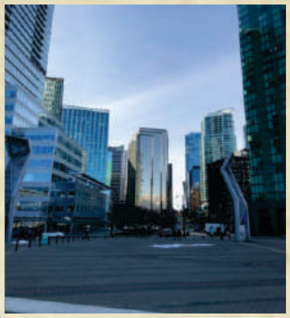
The transition from fossil fuels to renewable energy marks a pivotal moment in humanity's quest for sustainable development. As the environmental impacts of fossil fuel use, such as greenhouse gas emissions, climate change, and resource depletion, become increasingly severe, renewable energy offers a cleaner, inexhaustible alternative to address these challenges. Renewable sources like solar, wind, hydro, geothermal, and biomass minimize pollution, conserve natural resources, and reduce dependency on finite fuel reserves. Additionally, renewable energy creates significant economic opportunities, including job creation in the clean energy sector and technological innovation. Countries like India are leading this global shift, with ambitious goals such as achieving 50% of electricity from renewable by 2030 and reaching net-zero carbon emissions by 2070.

Environmental issues such as climate change, global warming, and ozone layer depletion have become more catastrophic. To solve the problem, more developing and developed countries are collaborating to increase the usage of renewable energy technologies. In doing so, various researches and innovations need to be carried out, and introduction of newer methods and components is very much welcomed for more efficient and affordable renewable energy-based power generation. This article reviews the current situation of renewable energy sources development and their limitations. Apart from technological advancement, to avail the benefits of renewable energy, affordable costing, incentives, friendly regulations, and social awareness and acceptance are required. Governments and non-governmental organizations need to play important role in these aspects.

The country, currently ranked fourth worldwide in wind and solar capacity, demonstrates the potential of large-scale adoption of renewable energy to power economic growth while protecting the environment. However, this transition presents both technical and socio-economic challenges.

The intermittency of solar and wind energy requires advanced storage solutions, such as thermal and electrical systems, to maintain reliability and efficiency. Innovative technologies like nuclear fusion and artificial photosynthesis hold immense promise for achieving permanent, sustainable energy solutions. Yet, the socio-ecological costs of resource extraction and infrastructure development for renewable energy—sometimes described as "fossil fuel+" due to its dependence on material resources—underscore the importance of evaluating supply chains and ecological impacts comprehensively. These issues call for greater investment in energy-efficient technologies, environmentally conscious innovations, and international collaboration to ensure that the benefits of renewable energy outweigh its associated costs.

Despite these hurdles, the rapid development of renewable energy systems reflects humanity's ability to adapt and innovate in the face of global challenges. From reducing environmental degradation to enhancing energy security, renewable energy systems offer the potential to transform



the global energy landscape. With supportive government policies, advances in storage and grid modernization, and widespread public adoption, renewable energy can pave the way for a resilient, eco-friendly future. A well-planned transition to renewable is not only a response to today's pressing energy demands but also an essential step toward safeguarding the planet and fostering sustainable growth for future generations.

Photo credit: ***Saikat Kumar Basu***

PREMIER OF THE DOCUMENTARY, 'A TRIBE LOST BEYOND OBLIVION' AT NANDAN

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Premier of the documentary: 'A Tribe Lost Beyond Oblivion' was conducted with great pomp and grandeur at the Nandan 3 theater, Kolkata, WB on October 20/2024. The documentary has been produced in 2024 by a social and environmental NGO, named Howrah Suparna and directed by multiple award winner and social documentary filmmaker, Sourav Sarkar. The program was hosted by Dr. Suparna Sanyal Mukherjee, Secretary and Chief Functionary, Howrah Suparna and the main protagonist of the documentary on the Dongriya Khond tribes of the Nyamgiri hills in Western Odisha.

"A Tribe Lost Beyond Oblivion" is a documentary film depicting the research activities of an anthropologist, Dr. Suparna Mukherjee, who explores the interiors of the villages at Niyamgiri Hills in Odisha, where the tribal community of Dongria Kondh stays. In light of the setback from the bauxite mining projects ten years back, the film depicts and questions the tribal development milestones, to the extent it is achieved till 2024. The film ends with the viewpoints of the anthropologist on tribal development and development of indigenous technologies, as well, in context of the Dongria Kondh community.

Dr. Sumanapal Bhikkhu, Chief Functionary of Bodhi Nidhi, initiated the program with hhisdivibe blessings and















Buddhist chants, welcoming the guest and participants. Ms. Krishna Sanyal, Founder, Howrah Suparna also blessed the production team for their dedicated effirt in maing this movie. Chief Guest, Mr. Gautam De, Ex Director ICCR Kolkata highlighted on the plight of the Dongriya Khond tribe, their rich socio-cultural history and the need to protect them. Special Guest: Captain (Dr.) Satish Minocha, President, Rotary Club South Extension, Kolkata emohasized the importance of the documentary in engaging public with the challenges of the tribal life and it's Relevance to our society. Guest of Honour, Dr. Shymali Acharya, Assistant Manager, Publications & Operations,Aajkal Publushing House, Kolkata emphasized thst it is important to leave the tribal communities in their unique environment while promoting tribal development while respecting their tribal culture, traditions and heritage intact. An e-book ritten by Dr. Suparna Sanyal Mukherjee and Saikat Kumar Basu; entitled, ' Dongriya Khond: The Resilient Soldiers of the Nyamgiri' published by Ilsheguri Publications was also launched fron husband august platform.

The director of the movie, Saurav Sarkar explained the trajectory of this short documentary, their objectives and challenges that he and his team faced during the production stage and how they overcame them. Mr. Debabrata Ghosh Malay, CEO of the Ilsheguri Publication, Howrah emphasized importance of including tribal studies in the primary, secondary and tertiary. Dr. Chanchal Das, from the creative team explained their next step will ve to continue oriducingva series of documentaries on social and environmental issues in the coming years. In addition to all the guests on the dias, Howrah Suparna felicitated Somnath Halder, Director of Photography, of documentary, Prof. Unus Molla, CEO, International Business Centre, eminent journalist Subhadip Roy; and social workers Niranjan Ghosh and Ananda Ghosh.

Photo credit: ***Saikat Kumar Basu***

BOOSTING IMMUNITY WITH CITRUS: THE ROLE OF CITRUS FRUITS AS SUPERFOODS DURING THE COVID-19 PANDEMIC

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Abstract
The COVID-19 pandemic has underscored the importance of a robust immune system, with diet and nutrition playing a crucial role. Citrus fruits, belonging to the Rutaceae family, are nutritional powerhouses rich in vitamins, pectins, carotenoids, fatty acids, and polyphenols, particularly valued for their high content of vitamin C, anthocyanins, and flavanones like hesperidin and naringin. These compounds exhibit potent antioxidant and anti-inflammatory properties, essential for bolstering the immune system. Citrus fruits may prevent and treat viral and bacterial infections, mitigate oxidative stress, and support immune health. During the pandemic, citrus fruits' high vitamin C content has been particularly beneficial in boosting immune responses and potentially reducing severe COVID-19 symptoms. The bioactive compounds in citrus, such as flavonoids, limonoids, and anthocyanins, offer significant health benefits, including anti-inflammatory, anti-hypertension, anti-atherosclerosis, and anti-cancer effects. Additionally, pectins found in citrus peels regulate intestinal functions and promote the growth of beneficial gut bacteria. The varied flavonoid content among citrus species enhances their health benefits, with specific compounds like hesperidin and naringin playing key roles. Citrus carotenoids, contributing to the fruits' vibrant colors, support immunity, eye health, and chronic disease prevention. Incorporating citrus fruits into the diet can enhance overall health and resilience against infections, making them an excellent addition to a health-conscious diet during the COVID-19 pandemic and beyond. This review highlights the critical role of citrus fruits in dietary strategies aimed at improving immune health and mitigating viral infection impacts.

The COVID-19 pandemic has highlighted the critical importance of maintaining a robust immune system, with diet and nutrition playing a pivotal role in supporting health. Citrus fruits, belonging to the genus *Citrus L.* in the *Rutaceae* family, have emerged as nutritional powerhouses during this time. Key species such as including sweet orange (*Citrus sinensis*), sour orange (*C. aurantium*), mandarin (*C. reticulata*), grapefruit (*C. paradisi*), pummelo (*C. grandis*), lemon (*C. limon*), citron (*C. medica*), lime (*C. aurantifolia*), kumquat (*C. japonica*), and various hybrids, are renowned for their globally significant both economically and nutritionally. Rich in vitamins, pectins, carotenoids, fatty acids, and polyphenols, citrus fruits are particularly valued for their high content of vitamin C, anthocyanins, and flavanones like hesperidin and naringin. These compounds exhibit potent antioxidant and anti-inflammatory properties, essential for bolstering the immune system.Nutritional deficiencies can impair immune function, increasing susceptibility to infections. The Mediterranean diet, known for its health benefits, includes high intake of bioactive substances such as polyphenols and vitamins A, C, D, and E. These compounds help combat oxidative stress and prevent cardiovascular diseases, atherosclerosis, and cancer. During the pandemic, changes in consumer behaviour affected food supply chains, impacting food production, agricultural practices, dietary patterns, and health management guidelines.

Fibers such as pectin, more present in the solid part, help regulate intestinal functions and hinder the absorption of LDL cholesterol. Citrus fruits may also have beneficial effects in preventing and treating viral and bacterial infections. Hesperidin is the glycosylated form of hesperetin, often used for its detection in plasma.Vitamin C, a major antioxidant in citrus fruits, is found in higher concentrations in the peels of oranges and lemons compared to their pulp and juice. Clinical trials suggest that combining vitamin C with Quercetin offers both antiviral and antioxidant effects, enhancing the immune response and improving recovery in COVID-19 patients. This underscores the vital role of nutrition in managing and mitigating the effects of viral infections.

Citrus fruits exemplify the concept of "superfoods" due to their high phytochemical content. Rich in antioxidants, micronutrients, and other bioactive components, they are an excellent addition to a health-conscious diet. They positively influence health markers such as blood pressure, body mass index, waist circumference, and fasting glucose levels.Citrus fruits and their bioactive compounds play a crucial role in supporting immune health during the COVID-19 pandemic. Their antioxidant and anti-inflammatory properties, combined with strategic nutritional supplementation, can significantly improve health outcomes and resilience against infections.

NUTRITIONAL PROFILE OF CITRUS

Citrus fruits are rich in essential vitamins and divided into two categories: fat-soluble (such as vitamins A and E) and water-soluble (such as vitamins C and B-complex, including B1, B2, and folate). Vitamin C, a crucial water-soluble antioxidant in citrus, is especially important for boosting the immune system, protecting cells from damage, and preventing infections. During the COVID-19 pandemic, maintaining a high intake of vitamin C is beneficial for overall immune health and potentially mitigating severe symptoms.Citrus species such as sweet orange (*Citrus sinensis*), lemon (*Citrus limon*), and grapefruit (*Citrus paradisi*) are particularly rich in vitamin C. This potent antioxidant not only neutralizes free radicals but also enhances the activities of human antioxidant enzymes like superoxide dismutase and catalase. For instance, extracts from *Citrus karna* peel, *Citrus limetta* peel, and *Citrus bergamia* juice have demonstrated significant antioxidant bioactivity.

Reactive oxygen species (ROS), such as superoxide anion, hydroxyl radicals, and hydrogen peroxide, are byproducts of metabolism that can cause oxidative stress if not balanced by the body's antioxidant system. Modern lifestyle factors can increase ROS levels, contributing to the pathogenesis of various diseases, including aging, arthritis, cancer, inflammation, and heart disease. Vitamin C, a major antioxidant found in citrus fruits, plays a crucial role in combating oxidative stress and supporting immune health, especially during the COVID-19 pandemic.

The primary antioxidant mechanisms of vitamin C include:

a) Direct Absorption and Neutralization of Free Radicals: Vitamin C effectively scavenges harmful free radicals, reducing oxidative stress.

b) Inhibition of ROS-Associated Enzymes: It inhibits enzymes such as NADPH oxidase, xanthine oxidase, and myeloperoxidase, which are involved in ROS pathways.

c) Enhancement of Antioxidant Enzyme Activities: Vitamin C boosts the activity of enzymes that protect against oxidative damage, such as superoxide dismutase and catalase.

d) High vitamin C content in citrus fruits like oranges, lemons, and grapefruits significantly contributes to their role as superfoods.

Anti-Inflammation

Inflammation, mediated by inflammatory cytokines like tumour necrosis factor-alpha (TNF-α) and interleukins, plays a pivotal role in various chronic inflammatory diseases, including those affecting the respiratory system. Citrus fruits, rich in bioactive compounds, have demonstrated anti-inflammatory properties that can help mitigate inflammation-related ailments.For instance, extracts from orange peel (*Citrus aurantium* L.) have been shown to suppress *UVB-induced cyclooxygenase-2* (*COX-2*) expression and prostaglandin E2 (*PGE2*) production. Additionally, they act as agonists of peroxisome proliferator-activated receptor-c (PPAR-c), exerting anti-inflammatory effects. Flavonoids, coumarin, and volatile oils found in citrus fruits exhibit potent anti-inflammatory activity, making them valuable supplements for protecting against or ameliorating chronic inflammatory diseases.Citrus fruits, with their diverse array of bioactive compounds, offer a natural and effective way to combat inflammation and enhance respiratory function. Incorporating citrus fruits into the diet can be beneficial in boosting immunity and promoting respiratory health during these challenging times.

Rich in other nutrients

Pectins

Found in the cell walls of citrus peels, pectins are complex polysaccharides composed of D-galacturonic acid and other sugars. They are primarily extracted from fruit processing by-products, making them cost-effective and environmentally friendly. Citrus pectins are used as stabilizers and thickeners in various foods, enhancing texture and quality. Notably, they serve as fat alternatives in food processing, promoting healthier eating options. Moreover, citrus pectins exhibit significant health benefits, such as anti-inflammatory properties, hypoglycemic effects, and cancer prevention (specifically colon and prostate cancers). They also promote the growth of beneficial gut bacteria and improve carotenoid bioaccessibility, although they may impair carotenoid absorption in the intestines.

Fatty Acids

Citrus fruits contain a mix of saturated fatty acids (SFAs) and unsaturated fatty acids (UFAs), with UFAs making up about 70% of the total fatty acid content. UFAs, particularly monounsaturated and polyunsaturated fatty acids, are known for their beneficial health effects, including reducing the risk of hypercholesterolemia, diabetes, and atherosclerosis. Key fatty acids found in citrus include linoleic acid, palmitic acid, α-linolenic acid, and oleic acid. These compounds are vital for maintaining metabolic health and supporting the immune system.

Bioactive compounds

Citrus Flavonoids: Composition and Health Benefits

48 flavonoids from 22 common Citrus species across various fruit parts (peel, pulp, seed, oil, juice, or whole fruit) are summarized. These flavonoids fall into five classes: flavones, flavonols, flavanones, flavanonols, and polymethoxylated flavones. Flavanones make up about 95% of Citrus flavonoids, while flavones, flavonols, and polymethoxylated flavones are present in lower concentrations. Some flavonoids are unique to Citrus plants and occur mainly as glycosides rather than aglycones. Common aglycones include naringenin, hesperetin, apigenin, nobiletin, tangeretin, and quercetin. Common glycosides include naringin, neohesperidin, narirutin, and hesperidin. Polymethoxylated flavones like sinensetin, isosinensetin, nobiletin, and tangeretin exist only as aglycone.

Citrus fruits are rich in natural plant polyphenols, crucial for plant defense. Hundreds of polyphenols, including over 250 flavonoids, have been identified in citrus. Flavonoids in citrus can be categorized into flavanones, flavones, flavonols, and anthocyanins.

Key Flavonoids and Their Effects:

Neohesperidosides (e.g., naringin, neohesperidin) contribute to bitterness. Rutinosides (e.g., hesperidin, narirutin) are tasteless. Anthocyanins cause pigmentation in bloodoranges.

Health Benefits:

Flavonoids reduce the risk of chronic diseases like cardiovascular disease and diabetes. They exhibit anti-inflammatory, anti-hypertension, and anti-atherosclerosis effects. Narirutin helps regulate blood glucose and reduce adiposity.

Flavonoid Content Variation:

Flavonoid levels decrease as citrus fruits mature. Example: Navel oranges' total flavonoid content drops from 538 mg/100 g dry weight (DW) to 69 mg/100 g DW at maturity.
Lemon pulps' flavonoid content ranges from 630 to 1460 mg/100 g fresh weight (FW).

Flavonoid Profiles in Different Citrus Varieties:

The flavonoid content of the red orange is mainly hesperidin (43.6 mg/100 mL), followed at a distance by narirutin (4.8 mg/100 mL) and dimidine (2.4 mg/100 mL).Naringin in Pummelo, erocitrin in Lemon, hesperidin in Mandarin and Sweet orange.

Table 1: Concentration of Flavonoid in Different Species of Citrus.

Flavonoid concentrations	
Navel oranges	95.3 mg/100 g FW
Common oranges	82.6 mg/100 g FW
Satsuma oranges	75.45 mg/100 g FW
Clementine groups	35.6 mg/100 g FW
Sanguine groups	56.9 mg/100 g FW
Hybrid groups	56.4 mg/100 g FW

Limonoids, including methyl nomilinate, isoobacunoic acid, isolimonexic acid, and limonexic acid, have been evaluated for their biological effects on SW480 human colon adenocarcinoma cells. Among these, methyl nomilinate was the most potent inhibitor of cell metabolic activity, as shown by MTT and EdU incorporation assays. A study reported that the anti-proliferative properties of limonoids from *Citrus limon* L. Burm were mediated through caspase-7-dependent pathways in breast cancer cells, with their cytotoxic effect being more pronounced in estrogen-responsive breast cancer cells. Additionally, combinations of limonoids and curcumin were effective in inducing apoptosis in SW480 cells. Furthermore, limonoids and curcumin exhibited synergistic inhibition of colon cancer cell proliferation, which was supported by increased total caspase-3 activity in the cells treated with these combinations.In the context of the COVID-19 pandemic, these findings highlight the potential role of citrus limonoids in supporting immune health and combating virus-induced cellular stress. The anti-proliferative and pro-apoptotic effects of limonoids, combined with their ability to synergize with other compounds like curcumin, suggest they may help mitigate the impacts of viral infections, including COVID-19. This underscores the importance of citrus fruits in dietary strategies aimed at enhancing immunity and reducing the severity of COVID-19 symptoms.

Anthocyanins

Anthocyanins are water-soluble flavonoids that play crucial roles in plant development and defense. These compounds, typically existing as glycosides due to the instability of their aglycone forms, are derived from flavylium cations. Although around 25 anthocyanidins are identified in nature, only six—pelargonidin, cyanidin, delphinidin, peonidin, petunidin, and malvidin—are commonly found in plant-based foods, linked to sugars such as glucose and rhamnose, and make up about 95% of all anthocyanins.Anthocyanins contribute to the color of plants and offer significant health benefits due to their antioxidant properties. They counteract oxidative stress and help prevent the progression of various non-communicable diseases, including neurodegenerative, cardiovascular, and metabolic diseases, as well as cancer. Additionally, they possess antimicrobial abilities and support visual health.

Blood oranges, such as Tarocco, Moro, and Sanguinello, are notable for their high anthocyanin content, which varies by variety, maturity, and environmental factors. Studies have identified ten anthocyanins in blood oranges, predominantly cyanidin and delphinidin derivatives. Cyanidin 3-(6"-malonylglucoside) and cyanidin 3-glucoside are the most abundant in Sanguinello and Tarocco varieties. Tarocco Ippolito and Sanguinelli have higher anthocyanin levels compared to TaroccoRosso.Pigmentation levels in blood oranges can vary significantly even under the same growing conditions. For instance, OTA9 has the highest pigmentation, followed by Moro, Tarocco, and Navelina. Cold treatment can extend shelf life and increase anthocyanin levels, likely due to the activation of enzymes involved in phenylpropanoid metabolism.

The accumulation of anthocyanins is closely related to fruit maturity. In Moro oranges, anthocyanin levels are undetectable in early stages but rise significantly in later stages, reaching 22.2 mg/100 g FW at peak maturity. This increase is linked to higher expression levels of genes encoding enzymes such as chalcone synthase (CHS), anthocyanidin synthase (ANS), and UDP-glucose-flavonoid 3-O-glucosyltransferase (UFGT).

Citrus Carotenoids

Citrus carotenoids, a class of C40 isoprenoids, include carotenes (hydrocarbonated carotenoids) and xanthophylls (containing oxygen). These compounds are significant for human nutrition and health, contributing to immunity enhancement, eye protection, and the prevention of cancer and cardiovascular diseases. They also impart the yellow, orange, and red colors to citrus fruits and can be converted into vitamin A, making citrus a valuable dietary source.Approximately 115 carotenoids have been identified in citrus species, with notable examples being -carotene, -carotene, lycopene, -cryptoxanthin, lutein, zeaxanthin, and violaxanthin. The total carotenoid content in citrus ranges from 2.5 to 50.1 mg/100 g fresh weight (FW), varying by citrus variety, maturity, and environmental conditions. Studies show that citrus pulp contains similar or higher levels of bioactive carotenoids compared to fresh juice, emphasizing the nutritional benefits of consuming whole fruit.Carotenoid content increases during fruit ripening as chloroplasts convert to chromoplasts, and environmental factors significantly impact their levels. For instance, violaxanthin and -cryptoxanthin accumulate predominantly in mandarins and oranges, unlike in lemons, pummelos, and grapefruits. The carotenoid composition can also distinguish between mandarins, oranges, and their hybrids, particularly by -cryptoxanthin concentration. Geographical differences affect carotenoid content, with variations noted in fruits grown in Mediterranean, subtropical, and tropical regions. Processing methods like thermal treatments and acidic conditions can alter the carotenoid structure, forming isomers and rearranging epoxy groups.

Improving carotenoid bioavailability is crucial for their health benefits, but their poor solubility and stability challenge human digestion. However, the presence of other dietary components, such as flavanones and pectin, can enhance their bioaccessibility. Storing citrus fruits at 12°C postharvest is a recommended strategy to preserve carotenoid content.

Recently, public interest has surged in the antioxidant properties of citrus fruits, linked to their high phytochemical and nutrient content. Epidemiological studies have shown a direct correlation between citrus consumption and a reduced risk of chronic diseases such as cancer, cardiovascular diseases, and diabetes.Additionally, citrus fruits contain curative components with pharmacological effects. Phytochemicals in citrus peel essential oils exhibit significant free radical scavenging and anti-fungal activity. Citrus pulp and peel have been used for their anti-pathogenic properties to alleviate sore throat, cough, earache, and vomiting. Extracts from citrus fruits and seeds have been used as sedatives and cardiac tonics.Citrus fruits, belonging to the evergreen Rosaceae family, are particularly notable for their health benefits.

Mechanisms of SARS-CoV-2 Infection and Potential Therapeutic Targets

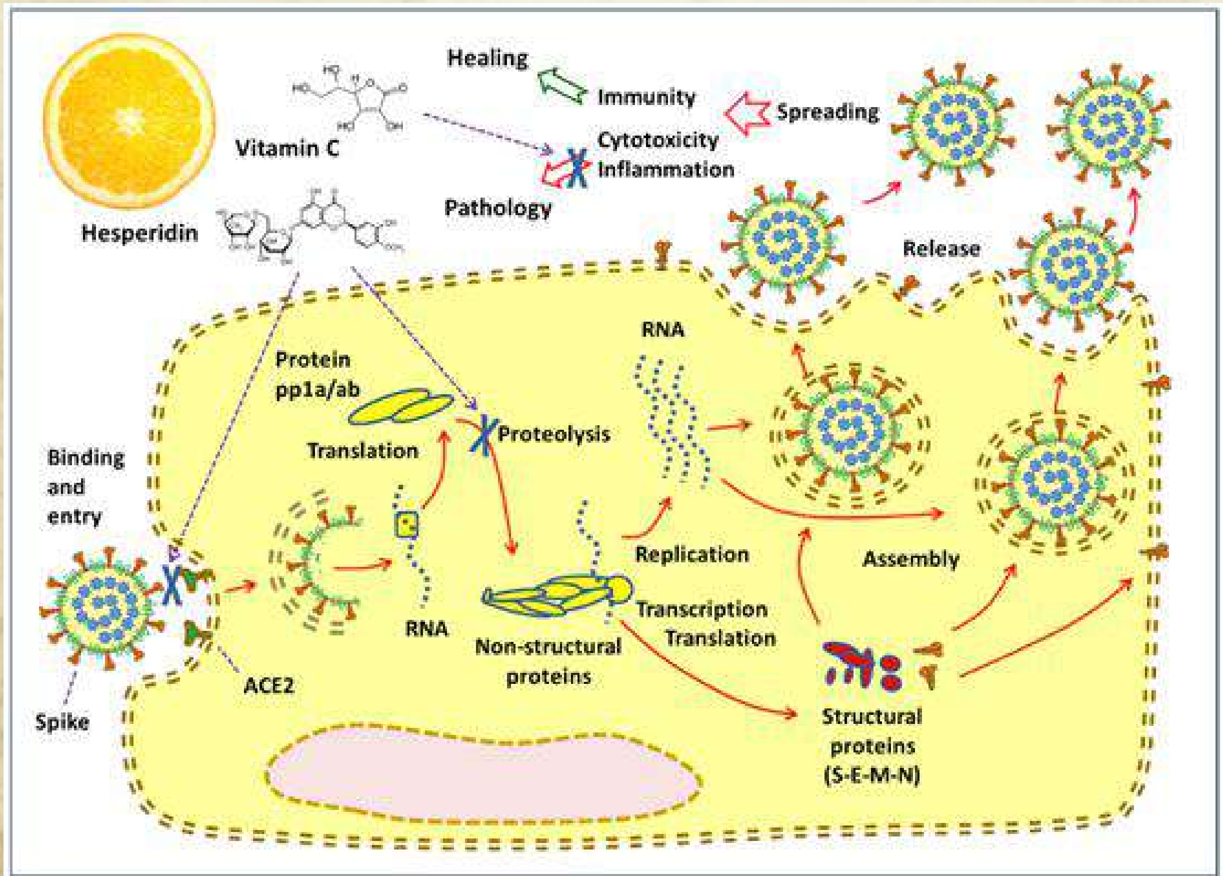

Figure 1: The cellular cycle of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and the sites where hesperidin and vitamin C inhibit virus-induced cellular and systemic pathology (Bellavite*et al.*, 2020)

The internalization of SARS-CoV-2 is mediated by the binding of the virus's spike glycoprotein to its receptor, ACE2, on cell membranes. Numerous tissues, including the brain and gastrointestinal and alveolar lung cells, express ACE2. Once the vesicle containing the internalized viral particle has had its envelope removed, the genomic RNA is released into the cytoplasm. The ORF1a and ORF1b RNAs are produced by the genomic RNA and then translated into pp1a and pp1ab proteins, respectively. These proteins are subsequently broken down by viral enzymes into 16 non-structural proteins. Some of these non-structural proteins form a replication/transcription complex (RNA-dependent RNA polymerase), which uses genomic RNA (+) as a template. Eventually, subgenomic RNAs produced through transcription are translated into structural proteins that form new viral particles. Structural proteins are incorporated into the membrane, and the nucleocapsid N protein combines with the positive-sense RNA to form a nucleoprotein complex. In the Golgi endoplasmic reticulum-apparatus, the various components assemble into complete viral particles, which are then excreted into the extracellular milieu.

The new copies of the virus spread into the environment and infect other cells and organs, leading to a chain expansion. When the viral load is high, and the cell is invaded by many viral particles, its protein synthesis apparatus is dedicated to viral replication, ultimately resulting in cell death. This final phase can occur via apoptosis (if death is slow and controlled) or through energetic-metabolic chaos, leading to the breakdown of various cell membranes, including lysosomes, and a total loss of structural integrity. Autoimmune phenomena may also be involved, with infected cells being attacked by T-lymphocytes and antibodies. As a result, inflammation develops both in tissues where many cells have died (primarily in the lungs) and systemically (affecting lymph, blood, immune system, coagulation, kidneys, and liver), which can be clinically severe, especially in patients with comorbidities. Excessive inflammation can be mediated by distorted cytokine network activation, clotting disorders, and paradoxical immune reactions (autoimmunity and cytotoxic lymphocytes).

Substances with potential beneficial effects against coronavirus infection may act at various stages: (a) preventing the virus from binding to receptors or inhibiting the receptor's function during internalization, (b) inhibiting viral replication by blocking RNA polymerase, proteases, or new particle assembly, (c) helping cells resist viral attack and stopping the cytotoxicity process, (d) blocking the virus's spread in the body, and (e) modulating inflammation when it becomes harmful. Specific antibodies produced by active or passive immunization (plasma, purified IgG) are prototypes for steps (a) and (d), although in coronaviruses, this mechanism can lead to complications such as antibody-dependent enhancement and autoimmune reactions. Step (b) is targeted by most antiviral drugs. Natural antioxidants could slow down the cytotoxicity process (step (c)), which involves oxygen-derived free radicals. Inflammatory disorders (step (e)) can be tackled with a variety of steroidal and non-steroidal anti-inflammatory drugs or new biological agents like receptor antagonists or anti-cytokine antibodies.

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SAVE OUR BEES

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Bees are very important to nature. There are about 20,000 species of bees in the world. Bees or honeybees or honeybees and honey-gathering insects closely related to ants. Famous for honey and wax production and flower pollination. There are about twenty thousand bee species in the world under 9 recognized genera, although most are undescribed and the actual number may be much higher. Wherever there are insect-pollinated flowering plants, there are bees on every continent on Earth except Antarctica.

Four types of bees are commonly seen in the country. Rocky Mountain Bee, Little Bee, Indian Bee and European Bee. Apart from these, another species known as stingless bee is found in Kerala. They are not stingless at all, in fact their stingers are not fully developed. But they are very good pollinators. They produce 300-400 grams of honey annually. Wherever there are flowering plants, there will be bees. They are very efficient and intelligent. Because bees and other insects cause flowers and fruits to grow on trees. If there were no insects like bees, there would be no flowers and no fruits on the trees. Bees live in colonies in groups. Bees live in a large family or society in each hive. There are three types of bees in a colony. Queen bee, worker bee and male bee. The queen bee is the leader of the group and is large in size. Bees are best known for their honey. But this honey is not made for us by the bees.

Rather, they collect honey for themselves in winter. They produce 2-3 times more honey than required. And understanding the opportunity, we take that extra honey. Researchers believe that not only honey production, but also the venom collected from bee stings can cure diseases. In recent times, it is heard that bees can play an important role in protecting the borders of the army. For which beekeeping is being done on the border.

Bee conservation is crucial for several reasons:
Pollination: Bees are among the most important pollinators in the world. They pollinate about 75% of the leading global food crops, including fruits, vegetables, nuts, and seeds. Without bees, many of these crops would fail, leading to a significant reduction in food diversity and availability.

Biodiversity: Bees contribute to the pollination of wild plants, helping to maintain biodiversity. These plants form the basis of many ecosystems, providing food and habitat for a wide range of other species. The decline of bee populations can lead to the collapse of these ecosystems.

Economic Impact: The agricultural industry heavily relies on bees for pollination, contributing billions of dollars annually to the global economy. The loss of bees would lead to higher costs for farmers and consumers, as alternative pollination methods would need to be implemented.
Environmental Health: Bees are indicators of environmental health. Their decline often signals broader issues within ecosystems, such as pesticide overuse, habitat loss, and climate change. Protecting bees means addressing these larger environmental concerns.

Food Security: A significant portion of the world's diet relies on bee-pollinated plants. The decline of bee populations could lead to a decrease in food production, potentially causing food shortages and higher prices, impacting global food security.

Protecting bees is not just about saving a single species but about preserving the delicate balance of our ecosystems, supporting agriculture, and ensuring a sustainable future for all.

Photo credit: ***Saikat Kumar Basu***