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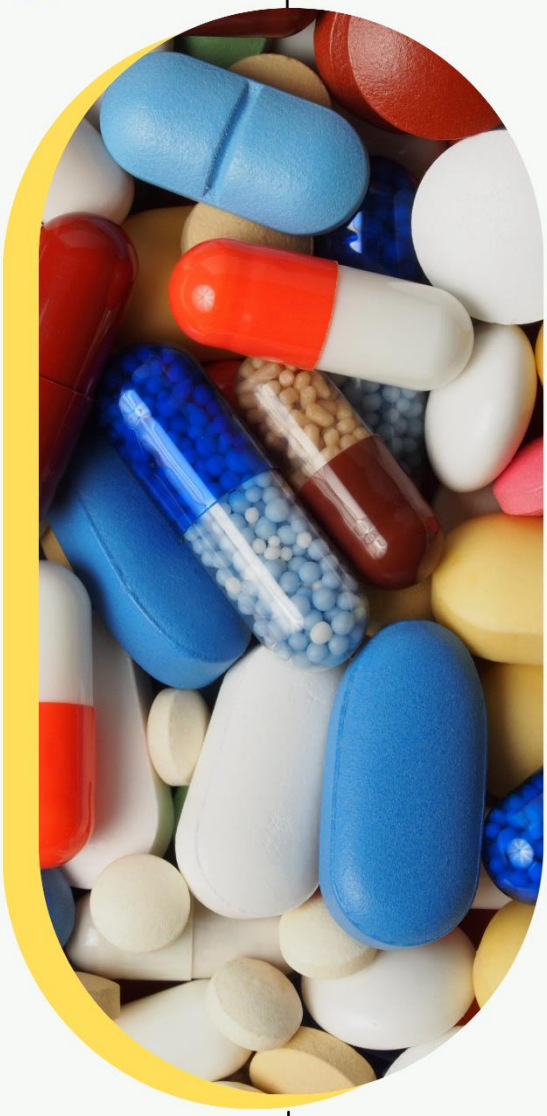
Prescriptions for Progress: Advancements in Pharma and Health Science Volume II



Editors:
Dr. R. S. Tayde
Dr. Ankita Sharma
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Editors

Dr. R. S. Tayde

Department of Veterinary Public Health & Epidemiology, College of Veterinary Science & Animal Husbandry, Mhow, Indore, M.P.

Dr. Ankita Sharma

ICAR-Farm Science Centre Sirohi, Agriculture University, Jodhpur, Rajasthan

Dr. Shafia Jan

Institute of Home Science, University of Kashmir, Srinagar, J&K

Mr. Sonam Bhutia

Government Pharmacy College, Sajong, Government of Sikkim, Sikkim University, Rumtek-Sajong, Gangtok-Sikkim

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E-mail: bhumipublishing@gmail.com

PREFACE

In the ever-evolving landscape of pharmaceuticals and health sciences, the pursuit of progress is relentless. Every day, researchers, clinicians, and innovators push the boundaries of what we know, challenging established norms and redefining the possibilities of medicine and healthcare. It is within this dynamic context that "Prescriptions for Progress: Advancements in Pharma and Health Science" finds its purpose.

This book is a testament to the extraordinary strides made in the field of pharmaceuticals and health sciences. It captures the essence of innovation, the spirit of collaboration, and the dedication to improving human health that drives the scientific community forward. Through a collection of insightful chapters, we explore groundbreaking discoveries, novel therapeutic approaches, and the cutting-edge technologies that are transforming healthcare as we know it.

The journey of creating this book has been one of profound learning and inspiration. We have had the privilege of engaging with some of the brightest minds in the field—scientists, researchers, healthcare professionals, and industry leaders—whose contributions have shaped the chapters within these pages. Their expertise and passion are evident in every word, offering readers a comprehensive and up-to-date understanding of the advancements propelling us into a healthier future.

Our goal with "Prescriptions for Progress" is not only to inform but also to inspire. We aim to highlight the challenges that have been overcome, the ongoing battles being fought, and the visions for a future where health science continues to break new ground. As you read through the following chapters, we hope you will gain a deeper appreciation for the intricate and multifaceted nature of this field, as well as the collaborative efforts that make such advancements possible.

This book is dedicated to all those who tirelessly work to improve human health. To the researchers in the laboratories, the clinicians at the bedside, the innovators developing new technologies, and the educators training the next generation of health professionals—your efforts are the true prescriptions for progress.

Editors

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ADVANCEMENTS IN BIOPHARMACEUTICALS AND TRANSLATIONAL RESEARCH: SHAPING THE FUTURE OF HUMAN HEALTH

Chetankumar M

BLDEA's SSM College of Pharmacy and Research Centre,

Vijayapura, Karnataka, India

Corresponding author E-mail: chetanpatil8123@gmail.com

Abstract:

This chapter explores the tremendous progress made in the biopharmaceuticals area as well as the critical role translational research plays in transforming the state of human health. It looks at the newest developments in immunotherapy, biologic treatments, personalized medicine, and biosimilars. The idea of translational research is further explored in this chapter, with particular attention paid to the creation of biomarkers and companion diagnostics, the significance of clinical trials, and the path from bench to bedside. It draws attention to the cooperative efforts, technical advancements, and moral and legal issues that are influencing healthcare's future. The difficulties in guaranteeing fair access to these cutting-edge treatments are discussed in the chapter's conclusion, along with potential future paths for advancement in this rapidly evolving profession.

Keywords: Biopharmaceuticals, Translational Research, Personalized Medicine, Immunotherapy, Biosimilars.

Introduction:

The biopharmaceutical industry has experienced remarkable growth over the past few decades, driven by cutting-edge research and technological innovations. These advancements are not only enhancing our understanding of complex biological systems but also translating into novel therapeutic approaches that significantly improve patient outcomes. Translational research plays a critical role in bridging the gap between laboratory discoveries and clinical applications, ensuring that scientific breakthroughs are effectively transformed into practical health solutions. This chapter provides an in-depth analysis of the emerging trends in biopharmaceuticals and the transformative impact of translational research on human health.

Emerging Trends in Biopharmaceuticals

1. Personalized Medicine

Personalized medicine, also known as precision medicine, represents a paradigm shift in the treatment of diseases. This approach tailors medical treatment to the individual characteristics of each patient, including genetic, biomarker, phenotypic, and psychosocial factors. Advances in genomics, proteomics, and bioinformatics are pivotal to the development of targeted therapies. Personalized medicine aims to enhance the efficacy and safety of treatments by:

- Identifying genetic mutations responsible for diseases.
- Developing targeted therapies that specifically address these mutations.
- Utilizing pharmacogenomics to determine the optimal drug and dosage for each patient.

2. Biologic Therapies

Biologics are complex medicines made from living cells and organisms. They include a wide range of products such as monoclonal antibodies, cell and gene therapies, and therapeutic proteins. Biologics offer highly specific mechanisms of action, making them effective in treating various diseases, including:

- **Cancer:** Monoclonal antibodies and CAR-T cell therapies target specific cancer cells with minimal impact on healthy cells.
- **Autoimmune Disorders:** Biologics such as TNF inhibitors and interleukin inhibitors modulate the immune response to reduce inflammation.
- **Genetic Disorders:** Gene therapies correct defective genes responsible for inherited diseases.

3. Immunotherapy

Immunotherapy leverages the body's immune system to combat diseases, particularly cancer. This approach includes several strategies:

- **Checkpoint Inhibitors:** These drugs block proteins that prevent the immune system from attacking cancer cells.
- **CAR-T Cell Therapy:** T cells are modified to express chimeric antigen receptors (CARs) that target cancer cells.
- **Cancer Vaccines:** Vaccines stimulate the immune system to recognize and attack cancer cells.

4. Biosimilars

Biosimilars are highly similar to approved biologic medicines, offering a cost-effective alternative. They provide comparable efficacy and safety, increasing patient access to biologic therapies. The development and approval of biosimilars involve:

- Demonstrating high similarity to the reference product through analytical studies.
- Conducting clinical trials to confirm comparable safety and efficacy.
- Navigating regulatory pathways to gain approval and market entry.

Translational Research: Bridging the Gap

1. From Bench to Bedside

Translational research aims to convert basic scientific discoveries into practical applications that improve patient care. This process involves:

- **Preclinical Research:** Conducting laboratory and animal studies to understand disease mechanisms and identify potential therapeutic targets.
- **Clinical Development:** Designing and implementing clinical trials to test new treatments in humans.
- **Implementation:** Integrating new therapies into clinical practice and monitoring their impact on patient outcomes.

2. Clinical Trials and Regulatory Pathways

Clinical trials are essential for evaluating the safety and efficacy of new treatments. Innovations in trial design and regulatory frameworks are enhancing the efficiency of the clinical trial process:

- **Adaptive Trials:** These trials allow modifications based on interim results, improving flexibility and efficiency.
- **Real-World Evidence Studies:** Utilizing data from real-world settings to complement clinical trial findings.
- **Expedited Pathways:** Regulatory agencies offer pathways like the FDA's Breakthrough Therapy designation to accelerate the approval of promising therapies.

3. Biomarkers and Companion Diagnostics

Biomarkers are critical for advancing translational research. They help in:

- **Diagnosis:** Identifying the presence of a disease.
- **Prognosis:** Predicting disease progression and outcomes.

- **Treatment Monitoring:** Assessing the response to therapy and adjusting treatment plans accordingly.

Companion diagnostics are tests developed alongside therapeutics to identify patients likely to benefit from a specific treatment, ensuring a more targeted approach.

4. Collaboration and Data Sharing

Collaboration among various stakeholders is vital for advancing translational research. Key initiatives include:

- **Public-Private Partnerships:** Collaborations between academic institutions, industry, and government agencies.
- **Consortia:** Groups of researchers and organizations working together on shared goals.
- **Data Sharing Platforms:** Open-access databases that promote the exchange of information and accelerate research progress.

FUTURE DIRECTIONS AND CHALLENGES

1. Technological Innovations

Emerging technologies are poised to drive future advancements in biopharmaceuticals and translational research:

- **CRISPR-Based Gene Editing:** Enabling precise genetic modifications to treat genetic disorders.
- **Artificial Intelligence:** Enhancing drug discovery, clinical trial design, and patient monitoring.
- **Advanced Imaging Techniques:** Providing detailed insights into disease mechanisms and treatment effects.

2. Ethical and Regulatory Considerations

The rapid pace of innovation raises important ethical and regulatory challenges:

- **Patient Safety:** Ensuring the safety and efficacy of new treatments.
- **Data Privacy:** Protecting patient information in an era of big data and digital health.
- **Ethical Implications:** Addressing the ethical concerns associated with genetic manipulation and other advanced therapies.

3. Access and Equity

Ensuring equitable access to advanced therapies is a significant challenge:

- **Healthcare Disparities:** Addressing disparities in healthcare access and affordability.

- **Global Access:** Implementing strategies to enhance access in low- and middle-income countries.
- **Capacity-Building:** Strengthening healthcare infrastructure and workforce to support the delivery of advanced therapies.

Conclusion:

Advancements in biopharmaceuticals and translational research are transforming the landscape of human health. From personalized medicine and biologic therapies to immunotherapy and biosimilars, these innovations are paving the way for more effective and targeted treatments. Translational research is crucial in bridging the gap between scientific discoveries and clinical applications, ensuring that new therapies reach patients promptly. Addressing ethical, regulatory, and access challenges is essential for realizing the full potential of these advancements. Continued collaboration, technological innovation, and a commitment to health equity will be instrumental in shaping a healthier future for all.

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FULLERENES IN BIOMEDICINE

Manasa C*[1] and Sandhya Rani Nagarajaiah[2]

[1]Department of Chemistry,

[2]Department of Physics,

Vidyavardhaka College of Engineering, Mysore 570 002, Karnataka, India

*Corresponding author E-mail: manasac@vvce.ac.in

Abstract:

Fullerene molecules, a carbon-based nanotechnology advancement, have gained significant attention in various scientific fields ever since their 1985 discovery. They have applications in biopharmaceuticals, dentistry, medicine, antioxidants, organic photovoltaics (OPV), and portable electricity. Fullerenes, particularly C60, have attractive optical, electrochemical, and physical features, making them useful in several medical sectors. They can suit into the hydrophobic chamber of HIV proteases, act as radical scavengers and antioxidants, and serve as carriers for drug and gene delivery mechanism. They are also utilized as MELDI material in the identification of biomarkers. Fullerene-based pharmaceuticals are being researched for nanomedicine applications due to their unique electrical properties. Recent research has focused on fullerene-based medications as antioxidants for inflammatory diseases, potential as viral and bacterial inhibitors, drug delivery systems, and the potential use of endohedral fullerenes as new MRI contrast agents.

Keywords: Nanotechnology, Fullerenes, Antioxidants, Photosensitizers, Drug Delivery, Therapeutic Agents.

Introduction:

Fullerene is a type of allotropic carbon with bonded carbon atoms organized in pentagonal and hexagonal rings. Named after Buckminster Fuller, it has advantages such as tight packing, solubility, low density, stability up to 1,000°C, and the potential to react with nucleophiles. However, it has disadvantages like light and oxygen degradation or breakdown and deactivation processes. Fullerenes are used in various applications, including organic photovoltaics (OPV), polymer additives, catalysts, water purification, biohazard protection catalysts, portable power devices, and vehicle components [1]. They also have medicinal uses, antibacterial activity, antioxidant and neuroprotective properties, pharmacological and gene therapy, and X-ray contrast agents. Fullerene derivatives can be

water-soluble and transport medicines and genes for cellular delivery in gene and drug therapy. They can attach to mitochondria via bridging cell membranes and can be used as X-ray contrast agents. Intercalation of fullerenes into biological membranes shows antimicrobial action, with favorable outcomes in bacterial and fungal strains. Fullerenes are also used in drug delivery, genetic engineering, and tissue engineering. Carbon nanohorns (CNH) are used to manipulate genes and atoms in bioimaging genomes, proteomics, and tissue engineering, while carbon nanotubes (CNTs) target amphotericin B to cells [2].

Fullerene is a type of allotropic carbon composed of bonded carbon atoms organized in pentagonal and hexagonal rings. Named after architect Buckminster Fuller, it has several advantages such as good tight packing, solubility, low density, stability up to 1,000°C, and the ability to react with nucleophiles. However, fullerenes have disadvantages such as light and oxygen degradation or breakdown and the possibility of deactivation processes.

Fullerenes have various uses, including medicinal applications, antibacterial activity, antioxidant and neuroprotective properties, pharmacological and gene therapy, and X-ray contrast agents. They can be used in organic photovoltaics (OPV), polymer additives, catalysts, water purification and biohazard protection catalysts, portable power devices, and vehicle components. Fullerene derivatives can become water soluble and transport medicines and genes for cellular delivery in drug and gene therapy. They can also attach to mitochondria via bridging cell membranes.

Fullerenes are also used in drug delivery, genetic engineering, and tissue engineering. Carbon nanohorns (CNH) are used to manipulate genes and atoms in bioimaging genomes, proteomics, and tissue engineering, while carbon nanotubes (CNTs) are used to target amphotericin B to cells.

Fullerenes have been applied in various fields, such as dentistry, implant prosthesis, anti-aging cosmetics, and diagnostic instruments. They work with zinc oxide to stop oxidation and are used in implant prosthesis to combat the body's rejection response that causes pain after surgery. Nanosize robots and motors using nanotubes can be used for studying cells and biological systems. Protein-encapsulated protein-filled nanotubes have been employed as implanted biosensors.

Fullerenes have been used in dentistry for various purposes, including tissue engineering, local anesthetic, hypersensitivity cure, orthodontic therapy, nanocomposite,

and caries prevention. Dental nanorobots can control nerve impulse traffic and provide patients with unnecessary and anxiety-free comfort. Fullerenes can also be used in the treatment of hypersensitivity by accurately and selectively occlude specific tubules in a matter of minutes.

Nanocomposites are being used in artificial teeth to be more abrasion-resistant and long-lasting, and toothpaste with calcium carbonate in nanosized particles can help remineralize early enamel lesions. Fullerenes, due to their unique structure, are being used in biomedical devices for drug administration, medical diagnostics, and therapeutics. They are not cytotoxic to animal and human cells in vitro and have minimal acute toxicity to animal tissues in vivo. Fullerenes can be chemically functionalized, suspended, or encapsulated to address their natural aversion to water. Chemical functionalization enhances the hydrophilicity of fullerenes, including amino acids, carboxylic acids, polyhydroxyl groups, and amphiphilic polymers. Fullerene derivatives include all known chemical compounds, indicating great chemical activity and a wide range of chemical interactions. Their remarkable chemical appearance piques curiosity for their potential use in developing innovative medicinal materials. Fullerenes have been demonstrated to possess antiviral, antioxidant, and drug transport qualities, making them a promising scaffold for photodynamic treatment and diagnostic applications. Drug delivery, antioxidant action, and antiviral activity are some of the medicinal uses for fullerenes.

Antiviral Activity

Fullerenes (C60) and its derivatives have shown potential antiviral properties, particularly in treating HIV infection [3]. These properties are due to their unique chemical structure and antioxidant potential. Dendrofullerene 1 and its trans-2 isomers have the strongest anti-protease activity and effectively suppress HIV-1 replication [4]. Two ammonium groups in fulleropyrrolidines have been found to be effective against HIV-1 and HIV-2 [5]. Fullerenes target HIV-1 protease, reduce Herpes Simplex Virus (HSV) entry into cells, inhibit influenza virus by inhibiting the hemagglutinin protein, and inhibit Hepatitis C Virus (HCV) replication by targeting viral proteins critical to the virus's life cycle.

Fullerene functionalization may contribute to an enhanced safety profile, and nanotechnology-based delivery methods such as liposomes or polymeric carriers are being investigated for targeted delivery. Fullerenes have been shown to be effective against the influenza virus by preventing the hemagglutinin protein, which is essential for the virus to merge with host cells. Studies suggest that modified fullerenes can lower the incidence of

HSV infection. However, there are several issues to consider, including toxicity, biocompatibility, delivery strategies, solubility and stability. Hydrophilic group functionalization can improve these issues under physiological settings.

Fullerene C60 (ADF) amino acid derivatives have been found to suppress human CMV and HIV replication [6]. Fullerene (C60) which are water-insoluable possess antiviral properties against encapsulated viruses, and after five hours of exposure to visible light, the vesicular stomatitis virus (VSV) or semliki forest virus (SFV) loses its infectivity in the existence of C60 [7]. Fullerene derivatives of the cationic, anionic, and amino acid types can prevent HIV-reverse transcriptase and the hepatitis C virus from multiplying [8]. The spatial hydrophobic interaction between the cavity sections and C60 of HIV-protease provides insight into the mechanism of action of fullerene derivatives on HIV.

The development of novel anti-HIV drugs could involve the production and Identification of fullerene compounds as inhibitors of the HIV aspartic protease enzyme. Research has also been conducted on a watersoluble fulllerene derivative using peripheral blood mononuclear cells (PBMCs) [9].

Photosensitizer

When exposed to light, fullerenes, especially C60 can generate reactive oxygen species (ROS) with remarkable efficacy, indicating their potential as photosensitizers. They have potential use in photodynamic therapy (PDT) for cancer treatment, antiviral drugs, and antibacterial treatments. Nevertheless, further research and development are needed to address the problems of toxicity, targeted specificity, and solubility. Fullerenes may be elated from their ground level to 1C60 by photoirradiation, and this may then be readily intersystem crossed to generate the long-lived 3C60. In the presence of molecular oxygen, fullerene can decay from its triplet to ground state, giving its energy to O2 and generating singlet oxygen. Species 1C60 and 3C60 with high energy can quickly decrease to C60•- by an unusual mechanism that involves the transfer of electrons in the presence of a donor.

Under biological circumstances, Biological reducing agents such as guanosin can be used to decrease the excited fullerene. Singlet oxygen and superoxide radical anions (C60•-) are known to be DNA-reactive, therefore they might be used as photosensitizers in photodynamic treatment (PDT). Research is being done on the possible anticancer effects of certain fullerene conjugates with distinct functional groups that possess a biological affinity for proteins or nucleic acids. In particular, C60 conjugates that interact with nucleic

acids to enhance cytotoxicity have been produced and include matching oligonucleotides or acridine.

The biodistribution and tumor absorption of radiotracer 125I-labeled C60(OH)x in five distinct tumor models have also been studied by Ji *et al.* [10]. Iwamoto and Ymakoshi introduced the most water-soluble fullerene to date, a C60-N vinylpyrrolidine copolymer, as a photodynamic therapy medication [11]. Magnetic resonance imaging (MRI) and photodynamic therapy using polyethylene glycol (PEG)-conjugated fullerene transporting Gd3+ ions were shown by Liu *et al.* [12]. Furthermore, they showed that the impact of tumor PDT was significantly enhanced by photosensitizer tumor targetability and MRI activity. The photodynamic activity of fullerenes modified with hydrophilic and cationic groups against a range of mouse cancer cell lines was examined in a research by Mroz *et al.* [13]. They discovered that the very potent photosensitizer monocationic fullerene quickly triggers the apoptotic process in cancer cells when exposed to light.

As photosensitizers, fullerenes provide a number of benefits, such as high ROS production, flexibility, functionalization, and photostability. Fullerenes may be important in a range of photosensitization-based medicinal applications with more study and advancement.

Antioxidant Activity

The biological antioxidant characteristics of fullerenes, a class of organic compounds, have been shown to be attributed to their low lying lowest unoccupied molecular orbitals (LUMO) and many conjugated double bonds. They are the most effective radical scavengers because of these characteristics, which allow them to target radical species. Fullerenes are useful as radical sponges because they may react with a diversity of superoxides without being disbursed. The capacity of fullerenes to concentrate inside cells to mitochondria and different cell compartment regions—where free radical generation occurs under disease conditions—is another benefit of fullerenes as medicinal antioxidants. A liquid C60 suspensions is made without polar organic solvents did not cause acute or subacute toxicity in the rats that Najla Gharbi *et al.* studied [14]. They also protected the rats' livers from loss affected by free radicals. Rats that underwent C60 pretreatment and CCl_4 poisoning did not suffer any liver damage, which can be explained by C60's strong molecule-level scavenging capabilities for free radicals.

Fullerenes may traverse the cell membrane and confine differently in mitochondria when derivatized with polar groups like C60 tris(malonic) acid and polyhydroxylated

fullerenes [15]. This mechanism generates a more quantity of cellular oxygen free radicals. Consequently, fullerenes have a broad variety of therapeutic uses, such as shielding cell development from toxins that might impair apoptosis in vitro in many cell types.

Numerous studies have examined fullerenes' ability to halt oxidative stress-induced apoptosis since many pathological and physiological processes depend on it. Studies by Daniela Monti and colleagues have demonstrated the ability of C60 tris(malonic) acid, additionally referred to as carboxyfullerenes, to avert apoptosis and preserve the integrity of the mitochondrial membrane potential [16]. Transgenic mice with a faulty human superoxide dismutase (SOD1) gene, which causes ALS (amyotrophic lateral sclerosis), were given C60 tris(malonic) acid by Dugan *et al.* Ten days after starting medication, the mice began to exhibit symptoms of disease, and they survived eight days longer than the untreated control group [17].

Additionally, the reason fullerenes are used is because they may protect cells from ultraviolet A (UVA) exposure [18]. Reactive oxygen species, which are created by UVA radiation, have the power to physically damage or kill human skin cells. Because water soluble fullerene derivatives, including fullerenols and malonic acid derivatives of C60, are particularly concentrated in the study of neurology, this is because the brain is mostly made up of unsaturated fatty acids and can only repair damaged tissue to a portion. Through its ability to scavenge intermediate peroxyl radicals, derivatives of fullerene can stop the chain process that leads to lipid peroxidation. By doing this, the radicals are kept from harming surrounding fatty acid chains or membrane proteins, which might result in cell death through apoptosis or excitotoxicity via glutamate receptor-mediated mechanisms. Studies conducted in vitro have demonstrated that fullerenes can halt lipid peroxidation, the process by which free radicals destroy the lipids in cell membranes and cause damage to cells. Furthermore, they have demonstrated the effectiveness of scavenging a range of free radicals, including hydroxyl radicals (•OH) and superoxide anions (O_2). According to in vivo research, fullerenes can lessen oxidative stress in tissues, which lowers inflammation and offers defense against oxidative damage. Fullerenes have been demonstrated to guard against oxidative damage in a number of organs, including the liver and brain, by increasing the activity of naturally occurring antioxidant enzymes including catalase (CAT) and superoxide dismutase (SOD). Cell research has shown that fullerenes are anti-inflammatory and can boost cell viability by reducing oxidative stress. Fullerenes are being researched as potential therapeutic agents in diseases such as

neurodegenerative disorders like Alzheimer's and Parkinson's disease, where oxidative stress is a key pathogenic component [19].

Gene and Drug Delivery

There has been a lot of interest in the direct transport of medications and biomolecules across cell membranes, with a particular focus on the expansion of effective and benign carriers for genes or medications. The nuclear membrane, the endosomal membrane, and the cell membrane are the three membrane barriers that make it extremely difficult to transfer any substance into the nucleus of an intact cell. Comprehending the entire process by which carriers reach cells is essential. Recombinant proteins, inorganic nanoparticles, organic cationic chemicals, and viral carriers are the four main categories of medication and gene carriers. Nanoparticles' remarkable biocompatibility, targeted, selective dispersion, and controlled release of pharmaceuticals make them useful as carriers for cellular delivery in a range of applications. Because fullerenes are tiny (~ 1 nanometer) and biologically active, they are often sold as inorganic nanoparticles. Both the chemical alteration and the characteristics of the fullerene core dictate their activity. Hydrophilic moieties are added to fullerenes to make them water soluble and capable of delivering medications and genes to cells. While DNA-functionalized fullerenes can enter COS-1 cells and exhibit effectiveness on par with or even higher than that of lipid-based commercial vectors, derivativeized fullerenes are able to pass the cell membrane and attach to the mitochondria. According to a biochemical analysis, the fullerene reagent prolongs the endosomal life of attached DNA and fosters chromosomal integration. DNA sequences are mostly linked by aminofullerenes.

Zakharian *et al.* developed a lipophilic slow-release drug delivery method that uses fullerene derivatives to improve therapeutic effectiveness in tissue culture [20]. Such a method might be offered by modified fullerenes, which also exhibit strong anticancer action in cell culture. Furthermore, fullerenes are finding more and more uses in cellular medication and gene delivery due to their ability to pass through undamaged skin. As it has distinct structure, which enables the functionalization and encapsulation of medicinal compounds, fullerenes have demonstrated promise in the transport of drugs and genes. They can be used as scaffolds or carriers to transport many kinds of medications, including as proteins, peptides, and tiny compounds.

Fullerenes are adaptable drug and gene delivery systems that have the potential to increase therapeutic intervention effectiveness and safety. Their distinct physicochemical

characteristics, in conjunction with developments in functionalization and formulation techniques, provide them appealing options for the precise and regulated administration of medications and nucleic acids. The stability of nucleic acids during delivery is improved by their encapsulation within fullerenes, which shields them from nuclease breakdown in bodily fluids. Enhancing the effectiveness of transfection, fullerenes can promote the cellular absorption of nucleic acid complexes via endocytosis. Additionally, by promoting endosomal escape, which is essential for effective gene expression, they can encourage the release of nucleic acids inside cells. Due to their low immunogenicity, fullerenes are good carriers for delivering genes with a lower chance of triggering an immune response. On the other hand, difficulties include regulatory approval, formulation optimization, specificity and targeting, and biocompatibility. To fully utilize fullerenes in medication and gene delivery, these obstacles must be overcome.

Conclusion:

The discovery of fullerenes has sparked the growth of an intriguing new scientific subject in recent years. Fullerenes are used in a wide range of sectors, including IT, diagnostics, medicine, dentistry, energy, and the environment. Technology breakthroughs are also being used to a number of dental specialties, such as dental restorations, composite resin and bonding systems, and coating materials for dental implants. A global upsurge in research and development endeavors has yielded an extensive array of prospective commercial uses, encompassing photodynamic therapy-based anticancer drug delivery systems, HIV medications, and skin-aging cosmetics. There are currently encouraging medical uses for fullerene and its derivatives when applied directly to biological targets. The fullerene core's distinct chemical and physical characteristics, particularly its photodynamic qualities, have drawn notice to them. The unique redox chemistry of fullerenes and their potential for reversible reduction by up to six electrons, combined with the compounds' minimal toxicity thus far, are reasons enough for biologists and chemists to collaborate and methodically study the biological characteristics of these intriguing compounds.

As fullerenes are made completely of carbon in the form of a hollow sphere and may be functionalized or encapsulated for simple solubility in physiologically appropriate aqueous environments, their special features can be advantageous to many current medical applications. Due to their intrinsic qualities, they have a high capacity for antioxidants at incredibly small sizes, which may be functionalized or adapted to suit a variety of medicinal

and diagnostic uses. Future studies in the realm of fullerenes may provide a wide range of commercial uses, including gene therapy, medication transport, antioxidant activity, antiviral, anticancer, photosensitizer, and very sensitive targeted diagnostic applications. The current fullerene research might make major advancements in suppressing or reducing the HIV infection's development to AIDS. Their strong antioxidant activity and distinct shape make them promising candidates for antiviral use. The compounds have a reasonably good structure-activity connection, allowing them to combine and inhibit the HIV protease. Furthermore, their great affinity for the enzyme's active site leads to a notable suppression of viral replication.

Additionally photoexcited, fullerenes have been used as photosensitizers, where they bind highly selectively to certain proteins and nucleic acids. Researchers have shown that fullerenes may photosensitize particular target cells by photodynamic therapy, potentially leading to a fast reduction in cell viability. Additionally, a theranostic version of this method has been developed that uses endohedral fullerenes containing gadolinium to photosensitize, target, and image tumor shrinkage over time.

Over the past ten years, significant progress has been achieved in advancing fullerenes as a useful platform to assist in addressing several contemporary medical restrictions. Further study is necessary to have a better understanding of the uptake, biodistribution, absorption, lifespan, excretion, and consumer safety of these nanostructures before successful research can be applied in the market.

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PHARMA INDUSTRIAL REVOLUTION: IMPACT ON INDIA AND CANADA

Nagaraj N Durgadasheemi[1] and Shivanand Kolageri*[2]

[1]Department of Pharmaceutical Chemistry,

R R College of Pharmacy, Chikkabanavar, Bengaluru-560090 Karnataka

[2]Department of Pharmaceutical Chemistry,

BLDEA's SSM College of Pharmacy and Research Centre, Vijayapura, Karnataka, India

*Corresponding author E-mail: ssmcop.skolageri@bldea.org

Abstract:

The pharmaceutical industry has undergone a significant transformation, often referred to as the "Pharma Industrial Revolution," which has dramatically impacted countries worldwide, including India and Canada. This book chapter explores the profound effects of this revolution on both nations, highlighting the changes in their pharmaceutical sectors, healthcare systems, and economic landscapes. We delve into the historical context, key drivers of change, and the roles of government policies and global market dynamics. Additionally, the chapter examines the social, ethical, and economic implications, providing a detailed comparative analysis of how India and Canada have navigated the challenges and opportunities presented by the evolving pharmaceutical landscape.

Keywords: Pharma Industrial Revolution, Pharmaceutical Industry Transformation, India Pharmaceutical Growth, Canada Pharmaceutical Innovation, Globalization and Market Dynamics.

Introduction:

The pharmaceutical industry has experienced rapid advancements due to technological innovations, regulatory changes, and globalization. This chapter focuses on how these developments, collectively known as the Pharma Industrial Revolution, have influenced India and Canada, two countries with distinct pharmaceutical landscapes.

The pharmaceutical industry has undergone a transformative evolution, often referred to as the Pharma Industrial Revolution, driven by advancements in technology, research, and global collaboration. This revolution has profoundly impacted nations worldwide, including India and Canada, reshaping their healthcare landscapes and economic structures. In India, the revolution has catalyzed the growth of a robust generic drug market, making it a global leader in pharmaceutical production and significantly improving access to affordable medications. Simultaneously, Canada's pharmaceutical

sector has experienced a surge in innovation, particularly in biotechnology and life sciences, fostering a dynamic environment for research and development. As these two diverse economies navigate the challenges and opportunities presented by the Pharma Industrial Revolution, their experiences offer valuable insights into the global shift towards more efficient, innovative, and accessible healthcare solutions.

Historical Context

1. India's Pharmaceutical Evolution

India's pharmaceutical industry has evolved from a fragmented market dominated by multinational companies to a global powerhouse in generic drug manufacturing.

- Pre-Independence Era: The pharmaceutical sector in India was underdeveloped, with limited local production and heavy reliance on imports.
- Post-Independence Policy Changes: The Indian government implemented policies to promote self-reliance, including the establishment of public sector units and the Patents Act of 1970, which allowed process patents but not product patents. This encouraged domestic production of generic medicines.
- Global Emergence: By the 1990s, India became a leading supplier of generic drugs, driven by cost-effective manufacturing and a strong scientific workforce.

2. Canada's Pharmaceutical Development

Canada's pharmaceutical industry has grown from a small-scale, domestic-focused sector to an integral part of the global pharmaceutical landscape.

- Early Beginnings: Canada's pharmaceutical sector initially focused on local production and meeting domestic needs.
- Regulatory Framework: The introduction of the Patent Act in 1987 and subsequent amendments strengthened intellectual property rights, attracting foreign investment and encouraging innovation.
- Innovation and Research: Canada has become a hub for pharmaceutical research and development (R&D), supported by government incentives and a robust healthcare system.

Key Drivers of Change

1. Technological Advancements

Technological innovations have been pivotal in transforming the pharmaceutical industries in both India and Canada.

- Biotechnology and Genomics: Advances in biotechnology and genomics have led to the development of personalized medicine, targeted therapies, and biopharmaceuticals.
- Automation and AI: Automation and artificial intelligence (AI) have optimized drug discovery, development, and manufacturing processes, increasing efficiency and reducing costs.

2. Globalization and Market Dynamics

Globalization has played a crucial role in shaping the pharmaceutical sectors of India and Canada.

- Outsourcing and Offshoring: India has become a preferred destination for outsourcing and offshoring pharmaceutical manufacturing and clinical trials due to its cost advantages and skilled workforce.
- International Trade Agreements: Trade agreements, such as the North American Free Trade Agreement (NAFTA) and its successor, the United States-Mexico-Canada Agreement (USMCA), have facilitated market access and collaboration in Canada.

Government Policies and Regulations

1. India's Policy Framework

Government policies have been instrumental in fostering the growth of India's pharmaceutical industry.

- Price Control and Accessibility: The National Pharmaceutical Pricing Authority (NPPA) regulates drug prices to ensure affordability and accessibility.
- Incentives for R&D: The government provides tax incentives and grants to encourage pharmaceutical research and innovation.
- Intellectual Property Rights: Compliance with the World Trade Organization's (WTO) Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement has enhanced patent protection, fostering innovation while balancing generic drug production.

2. Canada's Regulatory Environment

Canada's regulatory framework has supported the development of a competitive and innovative pharmaceutical industry.

- Health Canada's Role: Health Canada regulates drug approval, ensuring safety, efficacy, and quality. Streamlined approval processes have facilitated timely access to new therapies.

- Funding and Support for Innovation: The Canadian government provides funding for pharmaceutical R&D through agencies like the Canadian Institutes of Health Research (CIHR) and Innovation, Science and Economic Development Canada (ISED).
- Intellectual Property Protection: Strong intellectual property laws have attracted investment from multinational pharmaceutical companies, fostering innovation and growth.

Economic Impacts

1. India's Economic Transformation

The Pharma Industrial Revolution has significantly contributed to India's economy.

- Employment and GDP Contribution: The pharmaceutical sector is a major employer and contributor to India's GDP. The industry has generated millions of jobs, from R&D to manufacturing and sales.
- Export Growth: India's pharmaceutical exports have grown substantially, making it one of the largest exporters of generic drugs globally. This has strengthened India's trade balance and foreign exchange reserves.
- Foreign Direct Investment (FDI): Liberalized FDI policies have attracted significant foreign investment, enhancing technology transfer and industry growth.

2. Canada's Economic Development

Canada's pharmaceutical industry has also experienced notable economic benefits.

- Job Creation and Economic Output: The sector supports high-value jobs in R&D, manufacturing, and sales. It contributes significantly to the national economy.
- R&D Investment: Canada's focus on pharmaceutical R&D has led to the establishment of research hubs and collaboration with global pharmaceutical companies, driving innovation and economic growth.
- Export and Trade Balance: Pharmaceutical exports have grown, contributing positively to Canada's trade balance and economic stability.

Social and Ethical Implications

1. Accessibility and Affordability

Ensuring access to affordable medicines remains a critical issue in both countries.

- India's Challenges: Despite advancements, a significant portion of the population still lacks access to essential medicines due to affordability issues and distribution challenges.

- Canada's Universal Healthcare: While Canada's universal healthcare system ensures access to essential medicines, there are ongoing debates about drug pricing and the inclusion of newer, expensive therapies in public coverage.

2. Ethical Considerations

The rapid advancement of pharmaceutical technologies raises ethical questions.

- Clinical Trials: Ethical conduct in clinical trials, especially in developing countries like India, is a major concern. Ensuring informed consent and protecting participant rights are paramount.
- Intellectual Property and Equity: Balancing intellectual property rights with the need for affordable medicines is an ongoing ethical challenge, particularly in ensuring equity and access for all.

Comparative Analysis

1. Strengths and Challenges

A comparative analysis highlights the strengths and challenges faced by India and Canada.

- India: Strengths include cost-effective manufacturing and a large talent pool. Challenges involve regulatory enforcement, quality control, and ensuring equitable access to medicines.
- Canada: Strengths include a strong regulatory framework and robust R&D infrastructure. Challenges involve managing drug costs and ensuring timely access to new therapies.

2. Future Prospects

Looking ahead, both countries have opportunities to further enhance their pharmaceutical sectors.

- India: Continued investment in R&D, improving regulatory frameworks, and enhancing healthcare infrastructure will be crucial for sustained growth.
- Canada: Strengthening collaboration between government, academia, and industry, along with strategic investments in emerging technologies, will drive future advancements.

Conclusion:

The Pharma Industrial Revolution has profoundly impacted India and Canada, transforming their pharmaceutical industries and broader economies. While both countries have made significant strides, ongoing efforts are needed to address challenges related to

accessibility, affordability, and ethical considerations. By leveraging their strengths and addressing these challenges, India and Canada can continue to play pivotal roles in the global pharmaceutical landscape, contributing to improved health outcomes and economic development.

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UPDATE ON REHABILITATION IN PARKINSON'S DISEASE: A PHYSIOTHERAPEUTIC OUTLOOK

Mantu Paul

Department of Physiotherapy,

Composite Regional Centre for Skill Development,

Rehabilitation and Empowerment of Persons with Disabilities, Guwahati -781006

Department of Empowerment of Persons with Disabilities

Ministry of Social Justice & Empowerment, Government of India

Corresponding author E-mail: rtnmantupaul@gmail.com

Abstract:

Parkinson's disease (PD) is a devastating disorder of the human nervous system and the second most common progressive chronic neurodegenerative disease. The cardinal motor symptoms of PD are bradykinesia, rigidity, tremor and postural instability. Physiotherapists play a very important role in the rehabilitation of people with PD, particularly in relation to the management of motor symptoms, promotion of regular physical exercise and prevention of secondary impairments and complications. During the past decades, multiples studies have evaluated the efficacy of the various physiotherapy modalities, including comparisons across different interventions. However, the methodologies applied in these studies were highly variable and several different outcome measures were used. With recent progress, various forms of novice interventions have been used in the treatment of a patient with Parkinson's disease. In the coming times, the rehabilitation professionals including the physical therapists shall utilize modern use of updated techniques and methodologies as a part of their therapeutic treatment goals and plans to get the best results in the patients with Parkinsonism.

Keywords: Parkinson's Disease, Rehabilitation, Physiotherapy, Recent Trends

Introduction:

Parkinson's disease (PD) is a devastating disorder of the human nervous system and the second most common progressive chronic neurodegenerative disease. Approximately 6 million people worldwide are affected by Parkinsonism, which has a frequency of 51 to 439 per 100,000 people and an incidence of 2 to 28 per 100,000 people, according to door-to-door studies. The impact on men is marginally greater than on women. Age is a factor in both the prevalence and incidence of Parkinson's disease, which reach their peaks in the

seventh and eighth decades. Parkinson's Disease (PD) is caused by the progressive degeneration of dopaminergic neurons in the *substantia nigra pars compacta*, reduced striatal dopamine, and the presence of Lewy Bodies. The cardinal motor symptoms of PD are bradykinesia, rigidity, tremor and postural instability. The onset of the cardinal motor symptoms arises from the loss of dopaminergic neurons of the substantia nigra pars compacta, leading to depletion of dopamine in the striatum. Therefore, the inhibitory influence from the basal ganglia to other brain regions that are involved in the control and execution of voluntary becomes exaggerated, which may account for bradykinesia and rigidity.[1] The rate of progression and the particular symptoms differ among individuals. PD symptoms typically begin on one side of the body. However, the disease eventually affects both sides, although symptoms are often less severe on one side than on the other. People with PD often develop a so-called parkinsonian gait that includes a tendency to lean forward, taking small quick steps as if hurrying (called festination), and reduced swinging in one or both arms. They may have trouble initiating movement (start hesitation), and they may stop suddenly as they walk (freezing). Other problems may accompany PD, such as: Depression, Emotional changes, Difficulty with swallowing and chewing, Speech changes, Urinary problems or constipation, Skin problems, Sleep problems, Dementia or other cognitive problems, Orthostatic hypotension, Muscle cramps and dystonia, Pain, Fatigue and loss of energy, Sexual dysfunction, Hallucinations, delusions, and other psychotic symptoms. These symptoms have a substantial influence on patients' and their families' quality of life as the condition worsens, leading to increasing daily living challenges, increased dependency, and social isolation.

Content:

Physiotherapists play a very important role in the rehabilitation of people with PD, particularly in relation to the management of motor symptoms, promotion of regular physical exercise and prevention of secondary impairments and complications. Physiotherapy comprises of several varied treatment techniques, and novice physiotherapy interventions are incessantly being evolved. During the past decades, multiples studies have evaluated the efficacy of the various physiotherapy modalities, including comparisons across different interventions. However, the methodologies applied in these studies were highly variable and several different outcome measures were used. The mortality rate was lower in physically active than in physically inactive PD patients, and there was a significant inverse dose-response relationship

between the total amount of PA and all-cause mortality. Therefore, it seems necessary to evaluate the functional level of PD patients at the initial stage of the disease and plan rehabilitation strategies, including lifestyle modification, to slow the disease progression.[2] People with PD may show deficits in different aspects of balance function namely: biomechanical constraints and postural orientation (i.e., impaired flexibility, muscle weakness, stooped posture); limits of stability and verticality (i.e., camptocormia, lateral trunk flexion, inability to hold an inclined posture); anticipatory postural adjustments (i.e., diminished and delayed adjustments); reactive postural responses (i.e., excessive muscle co-activations, decreased stepping reactions); sensorimotor integration (i.e., over-dependence on visual cues, impaired processing of proprioceptive input); and dynamic control of gait (i.e., hypokinetic, shuffling gait, deficits in dual-task mobility).[3] Dynamic balance training has been suggested to improve postural balance, gait function, and the ability to perform activities of daily living (ADL) in patients with PD. Examples of balance exercises typically included flexibility/joint mobility exercises, weight shifting exercises, exercises of self-destabilization of the centre of mass, tasks that involve external destabilization of the centre of mass, balance exercises on unstable support surfaces, balance activities during walking that require continuous feedback and feed forward postural adjustments.[4]

In the last two decades, VR applications, including gaming devices, have been used as rehabilitation intervention tools.[5] VR had effects on balance, ADL, and further improved QOL. Exercise that incorporates virtual reality (VR) is also gaining popularity in the rehabilitation of people with PD. The intervention often involves the use of computer-based games in a virtual reality environment. Some examples include the Nintendo Wii or Xbox Kinect, which are commercially available, and other customized VR tools specifically designed to address PD impairments. Exergames, a combination of the words exercise and games, are intended to combine the enjoyable qualities of playing with the health advantages of exercise. Exergame PD rehabilitation is safe, practical, and effective—in certain instances; it's even superior to conventional rehabilitation and routine exercise.[6]

With recent technological progress, tele-rehabilitation has now become a viable option for managing patients with PD.[7] Tele-health involves the use of electronic information and telecommunication technologies to deliver healthcare services. It is particularly relevant to patients who have limited access to conventional face-to-face

rehabilitation services for a variety of reasons, including financial burden, lack of required services locally, and difficulties with travel due to long distance.

Non-invasive brain stimulation (NIBS) has also been tried in patients with PD to improve motor and cognitive functions.[8] A new non-invasive neurostimulation technique is transcranial direct current stimulation (tDCS). In comparison to primary motor cortex solo or sham stimulation, performance on a battery of FoG provocation tests was better when the primary motor cortex and left dorsolateral prefrontal cortex were simultaneously targeted. With simultaneous dual-target tDCS, improvements were also observed in the Timed Up and Go and Stroop test results. These preliminary findings emphasize the value of focusing on non-motor, particularly cognitive, brain regions.[9]

Aerobic capacity, as measured by the maximal oxygen consumption rate, is impaired in people with PD, particularly those with moderate to severe PD. Aerobic exercise may be a viable option to address the issues related to aerobics. Different modes of aerobic exercise have been studied in the PD population, with the most common ones being cycling on a stationary bicycle, followed by walking on a treadmill.[10]

Since advanced PD patients have reduced autonomicity during gait, there have been many trials of music-and dance-based therapy using regular rhythm. As for the type of dance, social dances such as tango, waltz, and foxtrot have been tried for PD.[11] Different types of dance have been studied, including Irish dance, ballet, Turo PD (a qigong dance hybrid), Ballu Sardu (a Sardinian folk dance), ballroom dancing, dance therapy specifically designed to address the PD symptoms, and a mixed genre.

Ambulation in daily living requires the ability to perform a cognitive or motor task while walking (e.g., carrying a glass of water or attending to traffic signals while walking). Dual-task exercise training in PD has gained increasing attention in recent years. It typically involves performing various walking and balance activities concurrently with cognitive tasks or upper limb motor tasks (e.g., carrying an object). Dual task training has been seen to improve gait and balance in patients with PD specifically; the improvement was attributable to increase in cadence rather than step length.[12] Dual-task training also improved motor symptoms [12], however, more high-quality research is needed to investigate its long term effects.

Hydro or Aquatic physical therapy (HPT) can be defined as a practice of methodologies and concepts in a heated pool whose objective is the kinetic recovery of a physically incapacitated individual. The liquid medium with the proper hygiene and

temperature enables the physiologic and therapeutic benefits for the PD patients. HPT uses the physical properties such as resistance noted in Archimedes' and Pascal's Principle. These hydro effects are versatile and can be advantageous for the use of therapeutic intervention of PD patients. Zotz *et al.* used the Halliwick Principles' 3-phase 10-point methods for acquisition of aquatic motor skills. They observed an improvement in their ability to float in prone and supine positions and longitudinal rotation in the bipedal position, so activation of motor control improved the motor skills of the participants.[13]

Common gait impairments in people with PD are: reduction in gait speed, step length and cadence; shuffling gait; difficulty with step initiation; and freezing of gait (FOG). Improving gait is one of the primary goals of physiotherapy in PD. Some of the better-studied training approaches include treadmill training. In gait training using a treadmill, a harness or a Partial body weight support was used in some studies to ensure safety and prevent falling. The effects of treadmill training in PD were examined in a number of systematic reviews, including a 2015 Cochrane review of 18 randomized controlled trials. The Cochrane review concluded that treadmill training improved gait speed and stride length, with moderate and low quality of evidence, respectively. However, the cadence and distance did not improve with treadmill training. The results seemed to suggest that treadmill training had a more pronounced effect on fast walking speed than comfortable walking speed.[14]

Nordic walking involves the use of two specially designed walking poles with rubber tips during walking. It requires the individual to perform arm swings using the poles as they move forward, similar to the movements observed in cross-country skiing. The use of poles during walking may promote postural adjustment and dissociation of the shoulder and pelvic girdles, and lessen axial rigidity, which may facilitate a better gait pattern. Improvements in motor outcomes (e.g., walking speed and endurance, leg muscle strength) and non-motor outcomes (e.g., depression, fatigue) were reported after Nordic walking training. A few studies also suggested that people with mild disability or gait impairment seemed to benefit more from Nordic walking training.[15]

To conclude, various forms of physiotherapeutic interventions are producing encouraging results in the treatment of Parkinson's disease. Hence, in the coming times, the rehabilitation professionals including the physical therapists shall utilize modern use of updated techniques and methodologies as a part of their therapeutic treatment goals and

plans to get the best results in the patients with Parkinsonism and thereby, bestow more in the development of overall health of a person with Parkinson's disease.

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NUTRITIONAL IMPORTANCE OF UNDER-UTILIZED FRUITS

Tejashwini Padakatti

Department of Food Processing and Nutrition,

Karnataka State Akkamahadevi Women's University, Vijayapura

Corresponding author E-mail: tjpadakatti@gmil.com

Abstract:

In India the most common underutilized fruits are Karonda (*Carissa carandas*), Bael (*Aegle marmelos*), Phalsa (*Grawia subinaequalis*), Ber (*Ziziphus mauritiana*), Jamun (*Syzygium cumini*), Lasora (*Cordia myxa* L), Aonla (*Emblica officinalis* Gaertn.) etc. These fruits are potential source of food, nutritional and medicinal values. Underutilised foods also possess therapeutic potential which when used efficiently can prevent and manage large number of degenerative diseases. These underutilized fruit crops can be low cost nutritious foods when understood and utilized effectively. In this review primarily emphasizing on the nutritional, therapeutic and other values of these fruit crops, highlighting few underutilized fruits available in India and their nutritional and potential health benefits to manage different diseases and disorders.

Introduction:

India is the centre of origin for variety of fruit trees, most of which are not planted commercially, but are a major source of livelihood for many rural and tribal communities. Many of these species are neglected, although a limited number of them are only cultivated for particular household uses in their native areas by local populations. India attained self sufficiency in food grains production after the introduction of green revolution in the country. In the current production technology, only major fruit crops are being targeted for improvement and for research purpose. The term 'underutilised' fruit crop has been described in various ways and mostly as conventional crops in localized areas only and overlooked by agriculture research and development agencies (Harpreet Singh 2020).

In general, fruits are rich source of vitamins and minerals. Use of various kind of seasonal fruits helps in keeping human beings healthy and hearty by fulfilling their various requirements. However, there are a number of underutilized fruits which have great medicinal values (Neeraj Gupta *et al.,* 2018).

Major fruit crops like Mango, Banana, Papaya Litchi, Guava etc. are commercially cultivated and comprises 75 percent of total area under fruit cultivation while the wild

edible fruits refer to species that are neither cultivated nor domesticated but it come from their wild natural habitat and used as one of the sources of food. Most of the underutilized indigenous fruit crops used as medicinal plants throughout India and popular in various indigenous system of medicine like Unani, Ayurveda and Homoeopathy. It was recognized that a high consumption of fruits and vegetables can help to prevent several non-communicable diseases such as cardiovascular diseases, the diabetes mellitus type -II and some cancer (Vinita Singh *et al.,* 2020).

Some wild fruits have been identified to have better nutritional value than cultivated fruits and a source of income for local population which are known as underutilised fruit plants. Underutilized fruit plants have poor shelf-life, unrecognized nutritional value, poor consumer awareness and reputational problems, therefore also called as poor people's food (Thakur M. 2014). These are also referred as minor, orphan, neglected, underutilized, underexploited, alternative, local, traditional marginal crops and have been included world-wide plans of action, after having successfully raised the interest among decision makers. The fruits and vegetables have plenty of natural antioxidants, like vitamin C and E, beta carotene, phenolic compounds such as antocyanin and other flavonoids which shows different benefits including antioxidant, anti-inflammatory, anti-carcinogenic properties. Some recent studies suggest that consumption of fruits and vegetables can reduce the risk of both cancer and cardiovascular diseases because they are rich source of Vitamin C and E, flavonoids and carotenoids (Pawan Kumar *et al.,* 2018).

Tropical fruits which are at present underutilized, have an important role to play in satisfying the demands for nutritious, delicately flavoured and attractive natural foods of high therapeutic value (Ravani and Joshi, 2014). Less popular underutilized fruits have been traditionally consumed as staple food and also for medicinal purposes. The fruits like karonda, bael, phalsa, ber, Jamun, lasoora, Aonla**,** jackfruit etc. are of great importance due to their medicinal properties.

Karonda

Commonly known as karonda, *Carissa carandas* belonging to family Apocynaceae are edible underutilized fruits. In India, it is grown on a limited scale in Rajasthan, Gujarat, Bihar, West Bengal and Uttar Pradesh. It is also grown in Sri Lanka lowland rain forests. Karonda is an indigenous protective fruit held in high esteem in Indian dietary.

Ripe karonda fruit contains high amount of pectin therefore it is also used in making jelly, jam, squash, syrup, tarts and chutney, which are of great demand in international

market Fruits of *Carissa carandas* being rich source of iron and vitamin C are used for curing anaemia. Decoction of its leaves is also used against fever, diarrhoea and ear ache, and the roots are used for stomachic, vermifuge, remedy for itches, and insect repellent (Manju Yadav *et al.,* 2018)

Chemical Composition of Karonda Fruit:

Nutrients	Nutrient value per 100g edible portion	
	Fresh Fruit	Dried Fruit
Energy (Calorie)	42	364
Moisture (%)	31	18.4
Protein (%)	1.1	2.3
Carbohydrate (%)	2.9	67.1
Fat (%)	2.9	9.6
Mineral (%)	-	2.8
Calcium (mg)	2.1	160
Phosphorus (mg)	28	60
Iron (mg)	-	39.1
Vitamin –C (mg)	200-500	1

Source: Tripathi *et al.,* 2013.

Medicinal uses of Karonda Fruit:

Karonda fruits are used in many ayurvedic formulations due to their nutritional values. Unripe fruit serves as a good appetizer. The extract of root is used for chest pain and leavesare used for fever (Sagrawat H., *et al.,* 2006). Moreover, it contains antioxidants such as flavonoids, alkaloids, tannins etc. which offer significant traits like analgesic, antiinflammatory, antipyretic and cardiotonic. Traditionally karonda fruits are used for medicinal treatments of malaria, epilepsy, leprosy, nerve disorder, fever, relieve of pain, headache, and blood purifier (Vinita Singh *et al.,* 2020).

Bael

The scientific name of Bael is *Aegle marmelos* and belongs to the family Rutaceae. All parts of the Bael plants i.e. leaves, seed, roots, bark etc are economical and possess different medicinal properties. The ripe fruit is a tonic, laxative and good for heart and brain. The mature fruit is astringent, digestive and is usually prescribed for dysentery and diarrhea. The Bael fruit contains large number of alkaloids, coumarins, essential oils and sterols hence, possess anti-inflammatory, antifungal, analgesics, antipyretic, wound

healing, insecticidal and antifertility abilities. The active factor for Bael is Marmelosin which acts as a remedy for stomach ailments. The fresh leaf juice if given in combination with honey acts as a laxative in fever, catarrh and asthma. Half ripe fruits are preferred for use in medicines preparation. Fruits are also used for scurvy, treatment of chronic diarrhea, peptic ulcers and to recover from respiratory problems (Harpreet Singh 2020).

Chemical Composition of Bael Fruit:

Nutrients	Nutrient value per 100g edible portion
Water (g)	57.46
Protein (g)	2.13
Fat (g)	0.3
Carbohydrates (g)	29.07
Ash (g)	1.3
Carotene (mg)	54.5
Thiamine (mg)	0.10
Riboflavin (mg)	1.03
Niacin (mg)	0.9
Ascorbic Acid (mg)	75
Tartaric Acid (mg)	1.98

Source: Singh 2012

Medicinal Uses of Bael Fruit:

All parts of the plant are economical and possess different medicinal values viz. leaves, roots, seed, bark and fruit etc contain a large number of coumarins, alkaloids, steroids and essential oils hence, possess analgesic, antiinflammatory, antipyretic, anti-microfilaria, antifungal, hypoglycemic, antidyslipidemic, immunomodulatory, antiproliferative, wound healing, anti-fertility, and insecticidal abilities (Bael, N *et al.,* 2017). The fresh leaf juice of bael fruit is very useful in doses of 8 to 16 gm is given with honey as a mild laxative in fever, catarrh and asthama. Half ripe fruits are mostly used in medicine and the fruit has characteristic aromatic, cooling and laxative properties. Fruit are also useful in controlling scurvy and strengthen the stomach and promotes its actions as reported by Joshi. Fruit are also useful in controlling scurvy and strengthen the stomach and promotes its actions as reported by Joshi33. Bael fruit is especially used in the treatment of chronic diarrhea, dysentery, and peptic ulcers, as a laxative and to recuperate from respiratory affections (Bakhru, H. K 1997).

Phalsa

Grewia Subinequalis (Phalsa) belongs to Tiliaceae family and native to India. Fruits of phalsa are acidic, good source of vitamin A, ascorbic acid and also rich in various other nutrients. Being highly perishable, the fruit must be utilized within 24 hours after picking.

The popularity of phalsa fruit is due to its attractive colour ranging from crimson red to dark purple and its pleasing taste. The juice when extracted gives a deep crimson red to dark purple colour and is very popular. It is rated very high in indigenous system of medicine. The juice is extremely refreshing and is considered to have a cooling effect especially in hot summer. Fruits contain 50-60 per cent juice and edible part of the fruits varies from 69-93 per cent. Generally, its fruits are consumed fresh (Boora and Bons, 2015).

The fruit is astringent and stomachic. It has been reported that when unripe, phalsa fruit alleviates inflammation and is administered respiratory, cardiac and blood disorders, as well as in fever reduction (Singh *et al.,* 2009). In addition, fruits are used for making excellent juice, squash, syrup and crush having cooling effect on the body (Boora and Bons, 2015).

Chemical Composition of Phalsa Fruit:

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	80.8
Carbohydrate (%)	21.1
Protein (%)	1.5
Fat (%)	0.9
Fibre (%)	1.2
Calcium (mg)	129
Phosphorus (mg)	39
Potassium (mg)	375
Iron (mg)	3.1
Vitamin B3 (mg)	0.3
Vitamin C (mg)	22
Vitamin A (carotene) ug	419

Source: Gopalan 2002.

Medicinal uses of Phalsa Fruit

Phalsa fruits work wonders in lowering down the high blood pressure to the normal range due to presence of benificial minerals like potassium and phosphorous. Furthermore, it also avert cardiac ailments of heart attack and heart functions, arrhythmia, atherosclerosis by preventing the deposition of fats in the blood stream and accumulation of cholesterol in blood vessels due to presence of anthocyanins, antioxidants and tannin. The antioxidant content is incredibly helpful in alleviating severe pain in bones, in stage of arthritis, osteoporosis and increase the movement of joints (Vinita Singh *et al.,* 2020). The unripe fruits of phalsa are revealed to alleviate inflammation and are administered in and blood disorders as well as in fever reduction (Morton, J. F 1987)

Ber

Ber or Indian Jujube (Zyziphus mauritiana) belongs to the family of Rhamnaceae. It is a native of Indo-China and India. It is also known as a poor man„s fruit, and one of the rich sources of nutrition. Ber fruit is normally eaten fresh are highly nutritious, rich sources of ascorbic acid, carbohydrates and contain fairly good amount of vitamin A, B complex, minerals like calcium, phosphorus and iron. Predominant phenolics found in ber relates to its major antioxidant activity, reducing power activity and scavenging of free radical activity. Fruit has great medicinal value, considered to purify blood and aid digestion. Ber fruits are mainly eaten fresh and dehydrated form as demonstrated by (Dar A I 2013) .

Chemical Composition Fresh Fruit of Ber

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	82.01
Carbohydrate (g)	5.4 - 10.5
Protein (g)	0.8
Fat (g)	0.07
Fibre (g)	0.60
Calcium (mg)	25.5
Phosphorus (mg)	26.8
Iron (mg)	0.76-1.8
Vitamin B3 (mg)	0.02-0.024
Vitamin C (mg)	65.8-76.0
Vitamin A (carotene) mg	0.021

Source: Morton 1987

Medicinal Uses of Ber Fruit:

Ber being rich in Vitamin A and C extend good protection against cough and cold. Ber fruit is a good source of energy too. It works in nervous system very effectively thus reducing fatigue and helps in regaining energy. The dried ripe fruit is a mild laxative. The seeds are sedative and are taken sometimes with buttermilk, to halt nausea, vomiting, and abdominal pains in pregnancy. The bitter, astringent bark decoction is taken to halt diarrhea and dysentery and relieve gingivitis. It is good rich source carotenes and phenolics (Tanmay, K. K 2011). Iron helps in preventing anemia by increasing the haemoglobin level of blood. Dried fruits are a good source of calcium, phosphorous, that helps in developing and maintaining bone density.

Jamun

Jamun (*Syzygium cumini*) the refreshing and curative properties of jamun make it one of the useful medicinal plants of India. Fruits are good source of iron. Jamun fruits are used as an effective medicine against diabetes, heart and liver trouble.The powder of seeds has high value being useful in the treatment of diabetes. Therefore, the jamun fruits are having high value in terms of therapeutic and nutrition. Antioxidant activity of Jamun is due to anthocyanins, gallic acid, quercetin etc. Juice is diuretic and prevents enlargement of spleen. The fruit extract prevents oxidation of LDL, control; prevent atherosclerosis, cancer, and cardiovascular/ inflammatory diseases. Seed powder used as diabetic medicine Consumption of fresh fruits purifies blood, avoids bad breath, Strengthens gum and teeth. Gargling of fruit juice cures throat pain. The fruits are good for phlegm, constipation and piles. The fruit juice sherbet is very effective against diarrhoea and dysentery. It is also good for diabetes. Fruit should be eaten after two hours of meal. It is good for liver; in turn it controls the blood sugar in the body. Consumption of fruits improves digestion and prevents tiredness (Yallesh Kumar HS *et al.,* 2018).

Chemical Composition of Jamun Fruit:

Nutrients	**Nutrient value per 100g edible portion**	
	Fruit	**Seed**
Moisture (%)	82.19	16.34
Crude protein (%)	2.15	1.97
Crude fat (%)	0.83	0.65
Crude fiber (%)	1.76	4.19
Ash (%)	2.04	2.18

Source: Yogendra Singh and Prerak Bhatnagar 2019

Medicinal Uses of Jamun:

The bark, fruits, leaves and seeds of jamun are used for medical purposes. The leaves and bark are used for controlling blood pressure and bleeding gums. Seed powder of jamun which able to reduces the sugar content in urine. Intake of Jamun is considered beneficial and cheaper way to control diabetes. The glucoside presence in jamun inhibits conversion of starch into glucose and thereby helps in reducing blood-sugar in the body. The seeds are used to treat a wide range of ailments, the most important being diabetes mellitus (Sagrawat *et al.,* 2006). Jamun seed has gastro-protective properties. In case of peptic ulcer jamun is very effective as it helps in promotion of mucosal defensive factors and antioxidant status and decreasing lipid peroxidation. Jamun also has anti-cancer and anti-viral properties. The seeds of jamun fruit is also have hypoglycemia, anti-inflammatory, antibacterial, anti-HIV and anti-diarrhoea effects. The powder of bark is applied externally to effectively reduce bleeding (Yogendra Singh and Prerak Bhatnagar 2019).

Lasora

Lasora (*Cordia myxa* L.) is also known as Gonda, or lehsua, belongs to the family Boraginaceae, that can be grown in moist and dry forests of India, except high hills and temperate climates. It is a medium sized, perennial tree with crooked stem. Lasora trees bears smooth, small cherry sized fruits in bunches from March to August. Other nutrients present in plants are: proteins, carbohydrates in the form of starch and free sugars, oils, ascorbic acid, minerals, and the antioxidant. Fruits are rich sources of natural antioxidants i.e. carotenoides, ascorbic acid, phenols etc. Lasora plant is considered as a multipurpose plant having association with nutrition, health and other diversified uses in curing some human ailments. Lasora tree provides food (pickle and vegetable), fuel wood and timber, thus play an important role in the rural economy of arid regions (Vinita Singh *et al.,* 2020).

Chemical Composition of Lasora: (Source: Aberoumand 2011)

Nutrients	Nutrient value per 100g edible portion
Carbohydrate (%)	57.08
Crude protein (%)	8.32
Crude lipid (%)	2.2
Crude fibre (%)	25.7
Potassium (mg)	7.83
Sodium (mg)	1.62
Calcium (mg)	0.46
Iron (mg)	0.51

Medicinal uses of Lasora Fruit:

The leaves of *Cordia myxa*, as well as those of many other species of the same genus, have been used in the traditional medicine of many countries for the treatment of various diseases (Rapisarda *et al.,* 1997) .Various parts of the lasora tree are used both internally, and externally for medicinal purpose. The tree is used traditionally in the treatment of fever, dyspepsia, ulcers, ringworm, headache, diseases of lungs, and spleen, etc. The bark, leaves, fruits, and seeds have been reported to exhibit antidiabetic, antiulcer, anti-inflammatory, diuretic, immune-modulator, Laxative, antidote, astringents, analgesic, expectorant, etc. activities. Presence of polyphenols in the Lasora fruit have been shown to have antibacterial, anti-inflammatory, anti-allergic, antiviral and anti-neoplastic activity. Many of these alleged effects have been linked to their known functions as strong antioxidant, free radical scavenger and metal chelators. The presence of steroidal compounds in the lasora (*Cordia myxa* L) is very useful in pharmacy because of their relationship with some compounds as sex hormones (Yogendra Singh and Prerak Bhatnagar 2019)

Aonla

The fruit is highly nutritious and rich source of pectin and polyphenols apart from ascorbic acid. The storage of Aonla depends on maturity at harvest. The fruit keeps well in cool chamber for 17-18 days as compared to 8-9 days at ambient temperature. It belongs to family Euphorbiaceae and is scientifically identifies as *Emblica officinalis*. Aonla fruits are sour and tangy and popularly made into juices, jams and pie-fillings for centuries. Aonla fruits are well known for their medicinal properties. Aonla fruits are used in traditional Indian systems of medicines, like ayurvedic and unani for treating ailments like common cold, gastric troubles, chronic diarrhea, dysentery, headache, constipation, enlarged liver, diabetics, bronchitis, jaundice and fever etc. (Agarwal and Chopra, 2004). It is an important natural capsule of ascorbic acid that contains 600 mg vitamin C/100 g of pulp. It has also other essential mineral nutrients like calcium, phosphorus, iron and vitamins such as thiamine, riboflavin, niacin etc. (Boora and Bons, 2015). The fruits however have excellent nutritive and therapeutic value, thus having great potentiality for processing into value added products.

Chemical Composition of Aonla Fruit:

Nutrients	Nutrient value per 100g edible portion
Moisture (%)	80.22 to 89.36
TSS (°B)	10.32 to 16.00
Acidity (% citric acid)	1.25 to 3.24
Ascorbic acid (mg/100g)	200 to 1500
Reducing sugar (%)	1.04 to 4.09
Non-reducing sugar (%)	3.05 to 7.23
Protein (%)	0.65 to 0.98
Pectin (% Ca pectate)	0.44 to 0.78
Total sugars (%)	7 to 9.6
Reducing sugars (%)	1.04 to 4.09
Non-reducing sugars (%)	3.05 to 7.23

Source: Singh *et al.,* 2004

Medicinal Uses of Aonla:

Aonla are rich source of phenols and tannins containing gallic acid, elegiac acid and glucose which prevent oxidation of vitamin C. A tablespoonful each of fresh aonla juice and honey mixed together forms a very valuable medicine for the treatment of several ailments like tuberculosis of lungs, asthma, bronchitis, scurvy, diabetes, anemia, weakness of memory, cancer, tension, influenza, cold, loss and greyness of hair (Chatterjee and Sil 2007).

Conclusion:

The minor fruits are reservoirs of several essential nutrient elements, vitamins and minerals and bioactive compounds are directly attributed to antioxidant properties against various free radicals. It is believed that regular consumption of these fruits will aid in preventing several diseases and disorders including obesity, diabetes and chronic diseases. They have a greater potential to cure several deficiency disorders and also increase the immunity against. These crops requires special attention and must be popularized to utilize their nutraceuticals values.

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IMPORTANCE OF MILLETS AND ITS TRADITIONAL FERMENTED BEVERAGES FOR HEALTHY LIFE

Shilpa* and Nataraj A Durgannavar
Department of Food Processing and Nutrition,
Karnataka State Akkamahadevi Women's University, Vijayapura
*Corresponding author E-mail: shilpacs1112@gmail.com

Abstract:

Millets are the small grains belongs to poaceae family which contains all the nutritents required for the growth and development of the human beings and they are called has nutri rich cereals. The millets contain 7-12% protein, 2-5% fat, 65-75% carbohydrates and 15-20% dietary fibre. Traditional foods are those which are prepared and eaten by many generations in the family. Millet based traditional beverages are prepared and consumed in many tribal areas during their special occasions and many research article and studies have proven that their beverages are having positive effect on consumers. These beverages contribute to overall wel-being of humans by promoting probiotic richness, improved digestion, nutrient density, boosted immunity, anti-inflammatory effect and many more.

Introduction:

Millets are a group of small-grained, annual, warm-weather cereals that belong to the grass family. These food crops are highly nutritious and are grown on marginal or low-fertility soils with very low inputs such as fertilizers and pesticides. Millets are nutritionally rich and a good source of carbohydrates, energy, protein, fiber, micronutrients, and photochemical when compared to major cereals like rice and wheat. These crops largely contribute to the food and nutritional security of the country.

More than 1/3rd of the world's population is consuming millets. Among cereal crop millets stands 6th in terms of world's agricultural production. In India, Karnataka is the leading producer of millets. Evidences shows that then have been cultivated for a thousand years and are used all over the world, in the Middle ages the Romans and Gauls were consuming porridges made of millets eaten than wheat. China, India, Greece, Egypt, and Africa generate a larger portion of the world's commercial millet crop. Millets account for more than 58% of global output, however few Indians are aware of its nutritional worth and health advantages (Ambati and Sucharitha, 2019).

Traditional foods are those which are prepared and eaten by many generations in the family. Traditional foods are having many medicinal and health benefit properties. Traditional food and beverage practices are location-centric and deeply associated with socio-religious and cultural norms and form a part of sociocultural and ecological life of indigenous folks. This kind of food and beverages might act as historical evidence regarding the origin of population in a region or the cultural significance of the concerned population group (Yovani, 2019). It is a popular traditional alcoholic drink served at weddings, family occasions and other local events, the ladies from all families gather together at a place for this purpose. Vikas Rana *et al.,* 2022. Traditional foods were often important for giving out, trade and ritual and also support livelihood and social prosperity (Amanda *et al.,* 2018)

Health Benefits of Millet

In India, millet consumption has decreased during the past few years. However, following that, consumption of millets increased quickly due to their nutritional profile and increased use, which prompted the diversification of millet-related processing technologies. This effort to eliminate inconveniences resulted in the development, improvement, and standardization of millet product technologies. For this reason, more products including extruded goods (such as vermicelli and pasta), flakes, savories, nutri-bar, and biscuits, among others, have been produced using primary processing and secondary processing techniques. These goods now have a longer shelf life and are suitable for commercialization. Millet goods produced through processing treatments had acceptable acceptability and improved nutritional content, convenience, and shelf life. The benefit of adding value to millets aids in raising knowledge of the nutritional and health benefits of millet products and reimagining them as wellliked, practical foods.

Types of Millets

Sl.no	Common name	Scientific name	Local name	Health benefits
1	Sorghum (Jowar)	*Sorghum bicolour*	Jola	Lowering digestibitity upon cooking which might be a health benefit for certain dietary group
2	Pearl millet (Bajar)	*Pennisetum glaucum*	Sajje	Rich in niacin, calcium and unsaturated fats It content high proportion of protein and lipids

3	Finger millet	*Eleusine coracana*	Ragi	Richest source of calcium(300-350mg), protein content is unique due to sulphur rich amino acid, high antioxidant activity
4	Foxtail millet	*Setaria italic*	Navane	Highest carbohydrates, sweet nutty flavour and most digestible and non allergic grain
5	Barnyard millet	*Echinochloa frumentacea*	Oodalu	Richest source of crude fibre and iron, grains posses functional constituents i.e., gamma amino butyric acid(GABA) and beta glucan used as antioxidant and in reducing blood lipid level
6	Kodo millet	*Paspalum scrobiculatum*	Harka	Rich is vitamin B and high amount of lecithin and is an excellent for strengthening the nervous system
7	Proso millet	*Panicum miliaceum*	Baragu	It content protein, significant amount of carbohydrate and fatty acids
8	Little millet	*Panicum sumatrense*	Same, save	High in iron and antioxidant activity
9	Brown top millet	*Brachiaria ramose/ Urochloa ramose*	Korale	It is used for therapeutic diet, good source of several minerals

Source: Nutritive value of India food, NIN, ICMR and FSSIA

Nutritional Value of Millets per 100g

Sl. No.	**Millets**	**Energy (Kcal)**	**Carbohydrate (g)**	**Protein (g)**	**Fat (g)**	**Crude fibre(mg)**	**Calcium (mg)**	**Iron (mg)**
1	Sorghum	349	72.6	10.4	1.9	1.2	42	8.0
2	Pearl(Bajar)	361	65.5	11.6	5.0	1.2	42	8.0
3	Finger	328	72	7.3	1.3	2.6	344	8.9
4	Foxtail	331	60.9	12.3	4.3	14	31	3.6
5	Barnyard	341	67	7.7	2.2	7.6	17	9.3
6	Kodo millet	302	69.9	8.03	1.4	8.5	22	9.9

7	Proso millet	309	65.9	8.3	1.1	9	27	0.5
8	Little millet	314	65.5	10.13	4.7	7.72	32	1.3
9	Brown top	338	67	7.7	1.89	8.2	28	1.99

Source: Nutritive value of India food, NIN, ICMR 2018

Millets are an approach for sustainable agriculture and healthy world

Food security	**Nutritional security**	**Safety from diseases**	**Economic security**
Sustainable food sources to fight hunger in the face of global climate change resistant to pests, illnesses, and climatic stress nutrition protection Contains many micronutrients, including iodine, calcium, iron, and zinc.	Rich in micronutrients like calcium, iron, zinc, iodine etc Rich in bioactive compounds Better amino acid profile	In celiac illnesses, gluten-free foods can replace wheat. Low GI foods are beneficial for diabetics. Can help to combat cardiovascular disease, anaemia, calcium deficiency etc.	Climate resilient crop Sustainable income source for farmers Low investment needed for production Value addition can lead to economic gains

Source: IIMR Value addition and market linkage and FSSAI

The Indian government has asked the UN to designate 2023 as the International Year of Millets (IYOM) in order to spur local and international demand and to give people nourishing meals. 72 nations agreed with India's request, and on March 5, 2021, the United Nations General Assembly (UNGA) proclaimed 2023 the International Year of Millets. In order to make IYOM a popular movement and increase the acceptance of Indian millets, recipes, and value-added goods abroad, the Indian government has planned to commemorate IYOM in 2023 (Ministry of Agriculture and Farmer Welfare).

According to research by Kimeera and Sucharitha (2019), the nutrients present in millets include resistant starch, lipids, oligosaccharides, antioxidants like

phenolic acids, flavonoids, lignans, and phytosterols. These nutrients help fight cancer, improve the digestive system, respiratory health, the neurological and muscular systems, and reduce the risk of heart disease and diabetes. Millets are abundant in photochemicals, and as a result of these photochemicals' functional and health-promoting properties, millet foods and beverages have a positive impact on diabetes, obesity, cardiovascular disease, and the immune system of the body.

Millet – Obesity

Millet are good source of dietary fiber leads to reduction of cholesterol decreases the incidence of obesity. Consuming high fibre food helps in improving the bowel function and reduce the prevalence of Obesity by improving the digestion and absorption in the body thereby reducing the risk of chronic diseases. Millets aid in controlling weight and lowering obesity in addition to satisfying hunger. (Lee, *et al.,* 2010)

Millets-Diabetes

Millets showed the results by reducing the α-glucosidase and pancreatic amylase thereby reducing the postprandial hyperglycemia by reducing the enzymatic hydrolysis of complex carbohydrates. Consuming millets helps controlling the blood glucose level and also helps in dermal wound healing process with the help of antioxidants. Sorghum based foods are having low GI and reduces the postprandial blood glucose level. Finger millet diets showed low glycemic response due to high fiber content (Shobana *et al.,* 2009).

Millets - Cancer

Millets showed results that they are rich phenolic acids, phytates and tannins which are the antinutrients which help in reducing the risk for colon and breast cancer. It is showed that phenolics in millets are effective in preventing the cancer initiation and progression in vitro (Chandrasekara A, *et al.,* 2011). The polyphones and tannins present in sorghum have anti-mutagenic and anti-carcinogenic properties) and can act against human melanoma cells, as well as positive melanogenic activity. In addition to their beneficial effects on scavenging free radicals, which can result in cancer, the antioxidants present in millets can also remove other toxins from your body, including those located in your kidney and liver.

Millets - Phytochemicals

Millets contain phytochemicals such as phenolics, sterols, lignans, inulin, resistant starch, -glucan, phytates, tocopherol, dietary fibre, and carotenoids that function as antioxidants and contribute to the immune system of the body. Antioxidants present in

millet have a positive effect on scavenging various toxins from the body, including those found in the kidney and liver, as well as neutralising the free radicals that can result in cancer. The soluble and insoluble bound phenolic extracts of different types of millet (kodo, finger, foxtail, proso, pearl, and tiny millets) demonstrate the antioxidant, metal chelating, and reducing properties (Chandrasekara and Shahidi, 2010)

Millets - Celiac Disease

Gluten ingestion causes the genetically sensitive condition known as celiac disease. Millets, which don't contain gluten, aid in lowering the prevalence of celiac disease by lessening the discomfort that glutencontaining common cereal grains cause. Millets' high fibre content aids in the eradication of conditions including constipation, excessive gas, bloating, and cramps. Millets are suitable for people with celiac disease since they are gluten-free and have a lot of potential in foods and beverages. They can also help meet the growing demand for gluten-free cuisine (Saleh *et al.,* 2013).

Millets - Probiotic and Prebiotic

Probiotics support the colon's natural flora or assist in repopulating it when antibiotics, chemotherapy, or illness lower bacteria counts. Young children's diarrhoea can be naturally treated with probiotics using products made from fermented millet. The entire grain of millet also exhibits prebiotic action, which aids in boosting the number of beneficial bacteria that are essential for promoting digestion. The millet grain undergoes significant, advantageous biochemical changes as a result of malting (Sitara and Singh, 2016).

Millets - Anti-Inflammatory Activity

It is reported good antioxidant effects of finger millet on the dermal wound healing process in diabetes induced rats with oxidative stress-mediated modulation of inflammation (Rajesekaran *et al.,* 2004).

Millets - Aging

Antimicrobial activity has been discovered in the millets fraction and extract. The capacity of seed protein extracts from sorghum, Japanese barnyard millet, foxtail millet, samai millet, and pearl millet to prevent the growth of Rhizoctonia solani, Macrophomina phaseolina, and Fusarium oxysporum was tested in vitro. All three of the tested phytopathogenic fungi are effectively stopped in their growth by protein extracts from pearl millet (Sitara and Singh, 2016).

Health Benefits of Traditional Fermented Beverages

Asian vessels discovered in archeological sites around 8000 B.C. provide the oldest indication of the use of fermented foods and beverages (McGovern *et al.* 2004). About 5% to 40% of human being consuming the fermented food in the world. Tamang *et al.,* 2016

Fermentation is the simplest and most economical way of improving their nutritional value, sensory properties, and functional qualities. As a result fermentation foods have become a very important part of the human diet worldwide because it involve the use of endogenous enzymes activated by germination or produced by microorganisms during fermentation (AmAdou *el al*., 2011).

The systematic consumption of traditional functional food provides an excellent preventive measure which wards off many diseases and maintains good health (Chaitra and Anbu 2018). Traditional meals are a reflection of cultural heritage and have influenced modern eating habits.

There is an increased interest in the consumption of traditional fermented products like foods and beverages either milk based, vegetable, or fruit based and cereal based in both nationally and internationally and also being produced globally, using a wide variety of different raw materials, microorganisms, and manufacturing techniques. It is estimated that now a days more than 3,500 different fermented foods and drink products, are being produced all over the world. Most of these products are manufactured in Asia, Africa, and in the Middle Eastern countries either in homes, villages or in small-scale industries (Bulent and Dobson, 2011).

Traditional food processing techniques usually involve the use of endogenous enzymes activated by germination or produced by microorganisms during fermentation. Fermentation can be spontaneously initiated without the addition of microorganisms or controlled through the use of specific cultures or starters from a previous batch of fermented product (Usha and Chandru, 1999).

In food processing, fermentation is primarily the anaerobic use of yeasts, bacteria, or a combination of both Marshall and Mejia (2011) during which microorganisms break down fermentable carbohydrates into end products such as organic acid, carbon dioxide, and alcohol ,as well as antimicrobial metabolites such as bacteriocins that increase food safety by killing or inhibiting food-borne pathogens.

The traditional millet beverage process includes malting, which involves three main operations: soaking, germination, and drying. The duration and situation of each

operation are highly erratic, resulting in highly variable malt and derived product quality by lowering blood cholesterol levels, boosting immunity, warding off infections, preventing obesity, diabetes, osteoporosis, allergies, and atherosclerosis, as well as soothing lactose intolerance symptoms, fermented foods have positive impacts on health (Sanliera *et al.,* 2017).

Ventakesh *et al.* (2019) Fermented traditional foods like Sura and MaduaAoong are finger millet based traditional fermented millet beverages prepared and consumed in Himalayan states and a Vitamin cynocobalamin, it is produced by the fermenting bacteria and is absent from finger millet. The essential amino acids like valine, threonine, leucine and isoleucine are in higher concentration in chang. Because of high calorie, ailing persons and post-natal women consume the extract of Chang to regain the strength.

Eu, a traditional mild alcoholic beverage made from millet and enjoyed by the Toto tribe in West Bengal and it as very low alcohol level (between 1-3%) and a good antioxidant capacity. Thirteen distinct bioactive chemicals were found via GC-MS analysis which found to be both safe and capable of scavenging reactive oxygen species (ROS) (Bhattacharjee *et al.,* 2021).

Fermented foods and beverages are valued as major dietary constituents in numerous developing countries which are contributing to food security because they add value, enhance nutritional quality and digestibility, improve food safety, and are traditionally acceptable and accessible and have minimal production cost, labor cost and relying on locally obtainable raw materials they are contributing to food security, of they have more shelf life under ambient conditions. Evidence shows that there are more than 3500 traditional fermented foods available worldwide proposed as causative mechanisms to the relationship of fermented milk consumption which decrease the circulating cholesterol concentrations (Monika and Dabur 2021).

Conclusion:

Millets are ancient grains not only offer superior nutritional content, but also contribute to sustainable agriculture and biodiversity conservation and traditional millet fermented beverages stand as not just cultural artifacts but as valuable assets to our health and culinary heritage. These beverages offer a unique blend of probiotics, vitamins, and antioxidants that promote digestive health, boost immunity, and contribute to overall well-being. Incorporating millets and traditional millet fermented beverages into our diets not only enriches our culinary experiences but also supports a healthier future for both

individuals and communities alike and we rediscover and integrate millets into contemporary lifestyles, we reaffirm their role in fostering holistic health and preserving culinary heritage worldwide.

Further Development of millet based traditional fermented beverages will help to broaden market positioning and enable reaching a wider number of population groups including children and the elderly and the combination of both products could be more easily accepted and successful in terms of consumer appreciation

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PERSONALIZED MEDICATION

Dipti Gohil*, Nirmal Shah, Sunil Kardani,
Kinjal Patel, Shivkant Patel and Rahul Trivedi
Department of Pharmacy,
Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat
*Corresponding author E-mail: diptigohil2014@gmail.com

Abstract:

Personalized Medication delves into the transformative potential of tailoring medical treatments to individual patient profiles, heralding a new era in healthcare. It begins by defining personalized medication, tracing its historical evolution, and highlighting its significance in contemporary medicine. Central to this approach is the integration of genomics and pharmacogenomics, which enable the identification of genetic markers that influence drug response. Ethical and legal considerations particularly concerning patient privacy, data security, and regulatory frameworks required to be analysed. There are economic implications and policy impacts of personalized medicine, including cost-effectiveness and insurance dynamics. Integration with electronic health records (EHR) can showcase the benefits and challenges of incorporating personalized approaches into existing healthcare systems. The perspectives of various stakeholders, including patients, healthcare providers, and pharmaceutical companies, are explored to underscore the collaborative nature of personalized medicine.

Keywords: Biotechnology, Patient-Centered, Tailored Treatment, Precision Medicine

Introduction:

Personalized medication represents a paradigm shift in healthcare, emphasizing the customization of medical treatment to individual patient characteristics. This approach leverages genetic, biomarker, phenotypic, and psychosocial information to tailor therapies that optimize efficacy and minimize adverse effects (1). The concept of personalized medicine is rooted in the understanding that each patient is unique, with distinct genetic makeups that influence their response to medications.

Historically, medical treatments have largely followed a one-size-fits-all approach, which often fails to account for the variability in patient responses. Personalized medication seeks to address this gap by integrating advanced technologies such as genomics, bioinformatics, and big data analytics (2-4). These tools enable the identification

of genetic markers and other individual factors that can predict drug response, paving the way for more targeted and effective treatments.

The importance of personalized medication is underscored by its potential to improve patient outcomes, enhance drug efficacy, and reduce the incidence of adverse drug reactions. By focusing on the individual rather than the population, personalized medicine aims to transform healthcare into a more precise and patient-centric field (5).

1. Biomarkers and Diagnostics

Biomarkers and diagnostics play a crucial role in the advancement of personalized medication, enabling the identification and implementation of individualized treatment plans. Biomarkers, which are measurable indicators of biological processes or diseases, provide critical insights into a patient's unique physiological and pathological state (6). These markers can be genetic, proteomic, metabolic, or even imaging-based, and they help predict responses to specific treatments, allowing for more precise and effective medical interventions.

The integration of biomarkers into diagnostics has revolutionized the way diseases are detected and managed. Advanced diagnostic tools, including genomic sequencing, proteomic analysis, and sophisticated imaging techniques, allow for the comprehensive assessment of a patient's condition at a molecular level (7-8). This detailed understanding facilitates the early detection of diseases, monitoring of disease progression, and evaluation of treatment efficacy, all tailored to the individual patient.

Genomic biomarkers, for instance, identify variations in DNA that affect how patients metabolize drugs, respond to therapies, or predispose them to certain conditions. Proteomic biomarkers provide information about protein expressions and modifications, offering insights into disease states and therapeutic responses. Metabolic biomarkers, which reflect the metabolic state of the patient, can indicate how well a patient might respond to a specific treatment.

The application of biomarkers in diagnostics supports the development of companion diagnostics—tests designed to identify patients who are most likely to benefit from a particular therapy. This approach minimizes the trial-and-error nature of traditional treatments, enhancing the precision of medical care (9-10).

However, the use of biomarkers and diagnostics in personalized medicine comes with challenges. Ensuring the accuracy and reproducibility of biomarker tests, addressing ethical concerns related to genetic information, and integrating these advanced diagnostics

into clinical practice require careful consideration. Regulatory approval processes must also keep pace with technological advancements to ensure safety and efficacy.

2. Individual Treatment Plans

Individualized treatment plans are the cornerstone of personalized medication, focusing on tailoring medical interventions to the unique characteristics of each patient. These plans are developed by integrating comprehensive patient data, including genetic, environmental, and lifestyle factors, to optimize therapeutic outcomes and minimize adverse effects (11).

The creation of individualized treatment plans begins with a detailed assessment of the patient's health status. This includes genomic analysis to identify genetic predispositions and variations that affect drug metabolism and response. Advanced diagnostic tools and biomarkers further refine the understanding of the patient's condition, providing insights into disease mechanisms and progression (12).

Healthcare providers use this information to develop customized treatment strategies. For example, in oncology, genomic profiling of tumors allows for the selection of targeted therapies that are more likely to be effective against specific genetic mutations. In chronic disease management, personalized plans may involve tailored medication regimens, lifestyle modifications, and regular monitoring to adjust treatments based on the patient's response (13).

Individualized treatment plans emphasize patient involvement and shared decision-making. Patients are educated about their condition and the rationale behind their specific treatment plan, empowering them to actively participate in their care. This collaborative approach enhances adherence to treatment and improves overall outcomes.

The benefits of individualized treatment plans are significant. They offer the potential for more effective therapies with fewer side effects, improve patient satisfaction and engagement, and reduce healthcare costs by avoiding ineffective treatments (14). However, implementing these plans requires advanced diagnostic capabilities, robust data analysis, and coordination across multidisciplinary healthcare teams.

3. Integration with Electronic Health Records (EHR)

The integration of personalized medicine with Electronic Health Records (EHR) is a pivotal advancement in modern healthcare, facilitating the seamless implementation of individualized treatment plans. EHRs serve as comprehensive digital repositories of patient health information, encompassing medical history, diagnostic results, treatment plans, and

more (15). This integration enhances the accessibility and utility of patient data, driving more precise and effective medical care.

Incorporating personalized medicine into EHR systems involves embedding genomic data, biomarkers, and other personalized health information within the patient's digital records. This integration allows healthcare providers to readily access and utilize this data when making clinical decisions. For instance, EHRs can flag potential drug interactions based on genetic profiles or suggest tailored treatment options informed by a patient's unique biomarkers (16).

The benefits of this integration are manifold. It ensures that personalized treatment plans are consistently and accurately applied across different healthcare settings and providers. Real-time access to comprehensive patient data enables more informed decision-making, improving the precision of diagnoses and the effectiveness of treatments. Additionally, it facilitates better coordination of care, as all members of the healthcare team can view and update the patient's personalized health information (17).

Moreover, EHR integration supports continuous monitoring and adjustment of treatment plans based on patient outcomes and new data, ensuring ongoing optimization of care. It also enhances patient engagement by providing them access to their personalized health information, empowering them to take an active role in their treatment.

However, integrating personalized medicine with EHRs poses challenges, including ensuring data privacy and security, maintaining data interoperability, and managing the complexity of incorporating vast amounts of genomic and biomarker data. Addressing these challenges requires robust IT infrastructure, clear regulatory frameworks, and ongoing collaboration among healthcare providers, IT specialists, and policymakers (18).

Future Trends and Innovations

The future of personalized medication is marked by groundbreaking trends and innovations poised to revolutionize healthcare. Central to this evolution is the continued advancement of genomic technologies, enabling even more precise identification of genetic markers and their implications for treatment. As genomic sequencing becomes faster and more affordable, it will likely become a routine part of medical care (19).

Artificial Intelligence (AI) and machine learning are set to play an increasingly vital role, analyzing vast datasets to uncover new patterns and predict treatment outcomes with greater accuracy. These technologies will enhance the development of personalized treatment plans, improving their precision and efficacy.

Wearable technology and digital health tools are expected to provide continuous monitoring of patients, offering real-time data on vital signs, activity levels, and medication adherence. This continuous data stream will enable more dynamic and responsive treatment adjustments, ensuring optimal care.

Another significant trend is the growth of telemedicine, which will facilitate personalized care regardless of geographic barriers, allowing for more widespread access to tailored treatments. Furthermore, advancements in biotechnology, such as CRISPR and other gene-editing tools, hold promise for correcting genetic disorders at their source (20). Collaboration among global health entities will be crucial, fostering innovation through shared knowledge and resources. Regulatory frameworks will need to adapt to keep pace with these rapid advancements, ensuring safety and efficacy while promoting innovation.

Conclusion:

"Personalized Medication" deals with the transformative potential of individualized treatment plans tailored to a patient's unique genetic makeup, lifestyle, and health conditions. Significant advantages of personalized medication, include improved efficacy, reduced adverse effects, and overall better patient outcomes. Advances in genomics, biotechnology, and data analytics facilitates these personalized approaches. Furthermore, there are few challenges such as ethical considerations, high costs, and the need for robust regulatory frameworks. The conclusion calls for continued research, collaboration between stakeholders, and the integration of personalized medicine into mainstream healthcare to fully realize its benefits. Ultimately, there must be a shift from the traditional one-size-fits-all approach to a more patient-centered model, promising a future where medical treatments are as unique as the individuals they are designed to help.

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PRESCRIPTION FOR A HEALTHY NATION: AN INNOVATIVE APPROACH

Faruk Alam[1], Rinchi Bora[1], Avik Dutta[2],
Alindam Ghosh*[2], Soumya Sunder Ghora[2] and Saurav Guchhait[2]
[1]Faculty of Pharmaceutical Science,
Assam down town University, Panikhaiti, Assam, 781026
[2]DmbH Institute of Medical Science, Dadpur, Puinan, Hooghly, 712305
*Corresponding author E-mail: alindamghosh1994@gmail.com

Introduction:

The word "prescription" is derived from the Latin term *praescriptus*—(*Prae* - 'before' and *"scribes*"- meaning 'to write').Prescription means 'to write before' which means a prescription had to be written before a drug could be compounded and administered to a patient (Kumar *et al.,* 2019)."Prescription" is the official way by which a physician authorizes a patient to get a specific medication or therapy in a proper scientific way by directing the pharmacist to prepare or dispense pharmacological agents/medications for the diagnosis, prevention, or treatment of a disease. It's a crucial aspect of healthcare, ensuring safe and effective management of medical conditions (Bannan *et al.,* 2021). This introduction will explore the importance of prescription, as well as its elements, rules, and obligations. Prescriptions contain essential details like patient information, medication name and dosage, administration instructions, and safety warnings. Compliance with prescription regulations and responsibilities ensures ethical practice and optimal patient outcomes (Iranmanesh *et al.,* 2020).

Parts of Prescriptions:

The various parts of a typical prescription are given below: figure 1

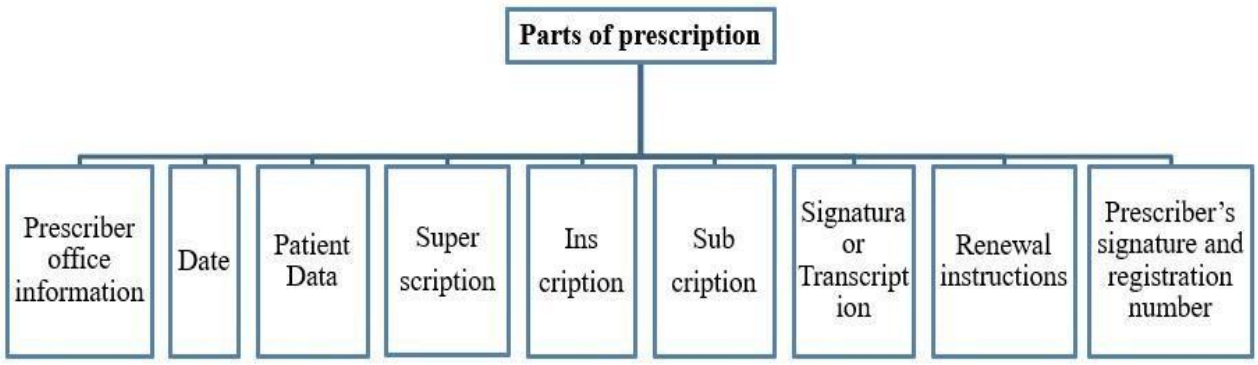

Figure 1: Different parts of prescription

- Prescriber's office information: When a prescription originates from a hospital or medical clinic, the name, address, and phone number of the hospital or clinic are listed first. The doctor's name and degree would be shown next to their signature in this scenario.
- Date: One of the most important components of a prescription is its date. This is because, in most circumstances, the right medication's countability is time-bound, and the date is crucial for that specific time-counting reason.
- Patient Data: The most important factors to consider while evaluating a patient are their name, age, sex, and body weight. A doctor can't treat a patient correctly without these specifics.
- The Superscription: The Latin sign (℞) can be used to represent this. The meanings of this sign include "recipe," "take thou," and "you take." Occasionally, the pharmacy itself is identified by this sign as well (Hoor *et al.,* 2016).
- The Inscription: It gives the medication's name and strength, either as the generic (nonproprietary) or brand (proprietary) name. The name and strength of the active components are stated in the inscription when the prescription is synthesized (Hoor *et al.,* 2016).
- The Subscription: This part provides the instructions given to the presenter and identifies the kind of dosage form or the quantity of dose units. For compounded prescriptions, the subscription is written using English or Latin acronyms (Hoor *et al.,* 2016).
- Signatura or Transcription: These instructions can be found written in Latin, English, or both. Although the number of Latin prescription directions is decreasing, it is nevertheless necessary to become familiar with them.in very simple words this is the direction to the patient regarding the administration (Hoor *et al.,* 2016).
- The renewal information: This is a section of a prescription for future guidance and instructions on the next scheduled appointment date. While it's not required to schedule an appointment every time, patients who are dealing with chronic illnesses must do so (Bannan *et al.,* 2021).
- The prescriber's signature and the registration Number. A prescription's authenticity is verified by the prescriber's signature, which demonstrates the fact that the drug has been authorized by a licensed healthcare provider. The registration number acts as a unique identity, guaranteeing accountability, tying the prescription to the

prescribing healthcare professional, and making tracking easier for legal and documentation needs. Collectively, they maintain professional standards, protect patient safety, and guarantee legal compliance with prescription practices (Hoor *et al.,* 2016) (Bannan *et al.,* 2021).

Ideal prescription:

In an ideal prescription, the name and dose of the medicine, directions for administration, a warning about potential risks, the prescriber's signature, and the patient's registration number are all included. It promotes safe and efficient drug administration for the most favourable patient outcomes by guaranteeing accuracy, accountability, and legal compliance. Before writing a prescription, consider the patient's past drug history. Consider other elements that might change the advantages and disadvantages of a certain course of care. Consider the thoughts, worries, and expectations of the patient. Choose medications that are safe, affordable, and effective for each patient (Nagesh *et al.,* 2014). An ideal prescription looks like this as given below: figure 2

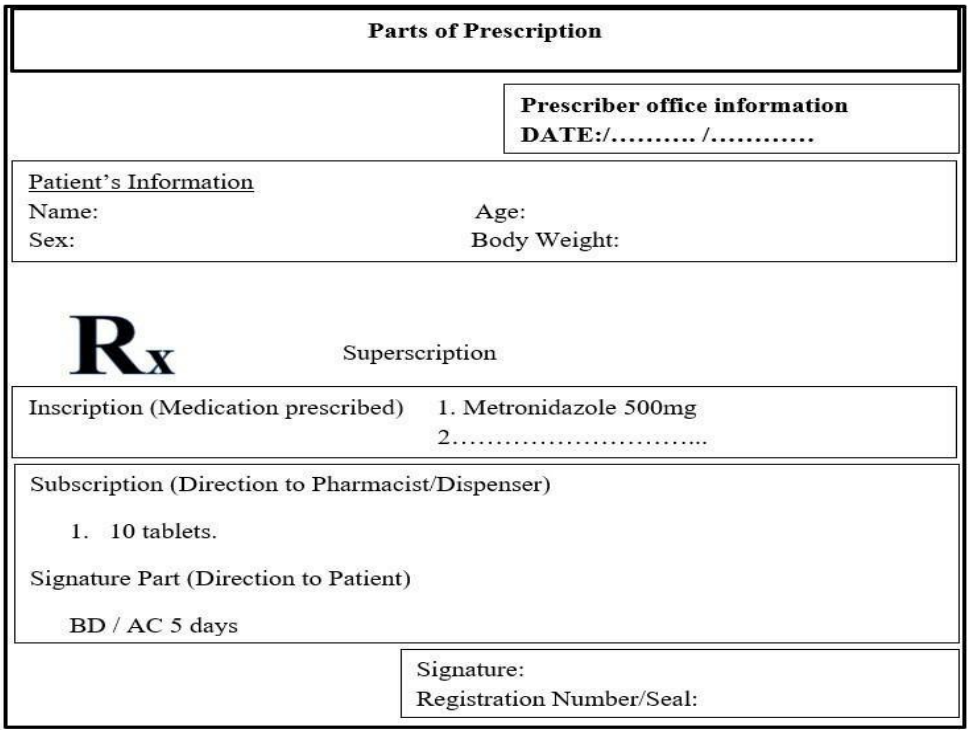

Figure 2: An Ideal Prescription Format

Types of Prescription:

The types of prescription shall be determined by two different factors, one is based upon the health care system where the patient comes for the treatment, and another one is based upon the formulation available in the market which are prescribed by the physician. Basis upon the health care facility: This kind of prescription is divided into two parts:

In-Patient Prescription

The term inpatient means medical care given to patients who need to spend at least overnight in a hospital or other healthcare institution is referred to as inpatient care. These individuals usually have more serious or intricate medical issues that require careful observation, specialist care, or surgery. Inpatient treatment provides resources for diagnostic testing and treatments, round-the-clock medical attention, and access to a multidisciplinary team of healthcare specialists. It enables thorough examination, treatment, and rehabilitation, fostering recovery and better health outcomes (Calligaris *et al.,* 2009).

Out-Patient Prescription

The term outpatient describes the medical treatments given to patients who do not need to spend the night in a hospital or other healthcare institution are referred to as outpatient care. These patients usually go to clinics, doctor's chambers, or outdoor departments. For less serious or chronic medical illnesses that don't need complicated procedures or close monitoring, outpatient care is appropriate. Compared to inpatient treatment, it is more convenient, flexible, and economical, enabling patients to get essential medical care without interfering with their everyday lives. To address a broad range of healthcare requirements, outpatient treatments include consultations, diagnostic testing, minor procedures, therapy sessions, and medication administration (Motghare *et al.,* 2016).

There are differences between the inpatient and the outpatient are as follows:

Table 1: The difference between inpatient and outpatient

In-Patient Prescription	**Out-Patient Prescription**
The patient stays in the facility	Patients stay at home but go to treatment during the day
Higher success rate	Lower success rate rather than inpatient service
Under 24 hours monitoring	Monitoring after a certain time interval.
More expensive for the patient	Comparatively less expensive.
Designed to treat a serious medical issue.	Good for someone with a mild addiction.

Basis of formulation being prescribed: This kind of prescription is also divided into two parts.

Pre-Compounding Prescription: These kinds of prescriptions are written by the physician as per the availability of the marketed product. The assurance of consistent quality, dosage, and availability of medications for common conditions reduces wait times and increases efficiency in healthcare institutions. Examples: Tab. Calpol 650.

Extemporaneous Prescription: When commercial medicines are either unavailable or inappropriate, improvisational prescription refers to the manufacture of personalized pharmaceuticals on demand that are suited to the specific needs of each patient. To provide individualized and efficient care, pharmacists or compounding experts carefully prepare and deliver these drugs depending on unique patient requirements (Kristina *et al.,* 2017). There are differences between the Pre-compounding and Extemporaneous prescription as follows, Table 2.

Table 2: The difference between pre-compounding prescription and Extemporaneous Prescription

Pre compounding prescription	**Extemporaneous prescription**
This is the prescription that contains the drug in available marketed form.	It is a prescription containing directions for the mixing together of the ingredients of a prescription or drug formula and the preparation of a therapeutic product for an individual patient in response to an identified need.
Pharmacists or nursing staff dispensed the medication as directed by the physician.	The pharmacist or nursing staff prepares the drug and dose according to the physician's instructions.
Most commonly used in this era.	Seen in limited scenarios, especially in Ayurveda and homeopathic medication.
Comparatively safer	Higher risk

Prescription Error:

A prescription error takes place when one or more normal characteristics of a prescription are written incorrectly due to a breakdown in the prescription writing process (Sapkota *et al.,* 2011). Different kinds of prescription errors are shown in Figure 3.

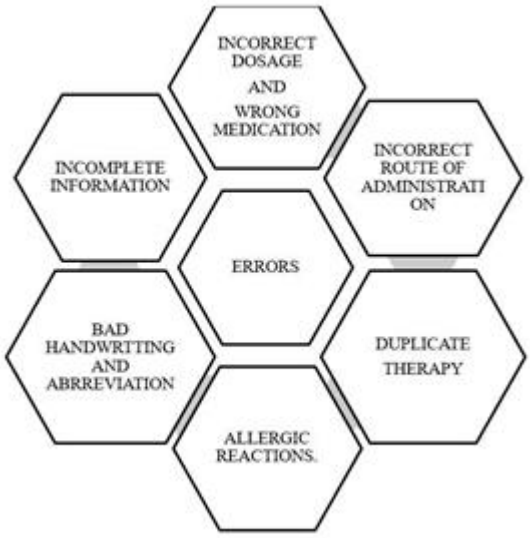

Figure 3: Types of prescription errors

Handling of Prescription Errors: Healthcare providers can follow the best practices to avoid such errors as

- Verifying patient data and drug information multiple times using the computerized system for electronic prescriptions.
- Informing the patient about the prescription they are taking.
- Maintaining the patient's updated record. Allergy and prescription drugs are taken currently.
- Educating medical personnel about medication safety through comprehensive training. Patients can also participate by making sure they understand their medicine, asking questions regarding their prescriptions, and making sure the pharmacy fills their orders correctly (BeexOosterhuis *et al.,* 2013).

Modernisations of Prescription

The modernization of prescription involves the integration of digital technologies to enhance efficiency, accuracy, and patient care. By enabling healthcare practitioners to electronically send prescriptions to pharmacies, electronic prescribing systems help to cut down on mistakes and delays that come with paper-based procedures. Clinical decision support is provided by advanced computer tools, which assist medical professionals choose the right drugs and doses based on patient-specific criteria. By enabling remote consultations and medication refills, telemedicine platforms increase access to medical care. In addition, mobile applications enable patients to access instructional materials, manage prescriptions, and get medication reminders all of which contribute to better

health outcomes and medication adherence in the digital age (Rath & Pattanayak, 2019). The several techniques used in the healthcare facilities are given below in Figure 4.

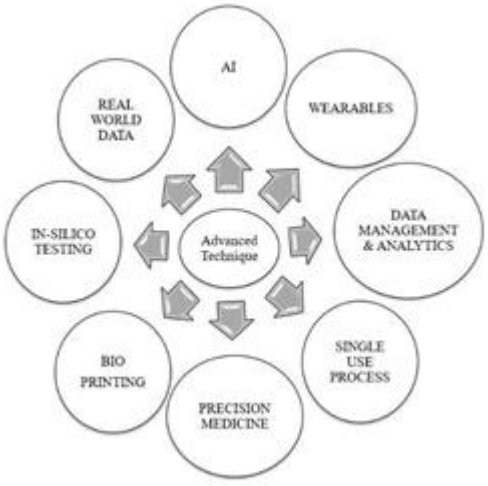

Figure 4: Advanced techniques used in the modern healthcare system

Advanced Technique in Modern Healthcare Systems:

The pharmaceutical industry has been traditionally slow to embrace new technology, but the advanced techniques used in the modern healthcare system are signs of a massive paradigm shift in the industry. Pharmaceutical businesses may now perform testing in novel ways, produce individualized medicines, and speed up research and development thanks to cutting-edge technologies like Augmented Reality (AR)/Virtual Reality (VR), Artificial intelligence (AI), and additive manufacturing. In the end, these technologies improve the effectiveness and efficiency of healthcare, changing both the patient and provider experiences (El & El, 2019).

Following is the leading healthcare technique in pharmacy and healthcare sector:

Artificial Intelligence

Healthcare is becoming more and more reliant on Artificial intelligence (AI). AI has already benefited the industry Because of its enormous predictive and data analytics qualities. Healthcare practitioners may now utilize AI to examine trends in data sets and get insight into the potential drawbacks, advantages, and success rates of new medications before bringing them to market (Sanjeev *et al.,* 2021).

A British business entitled Pangaea Data employs AI in conjunction with Machine Learning (ML) for clinical trials and real-world evidence (RWE) investigations. Pangea Data can identify patients by scanning electronic health data and unreadable physician notes using software driven by machine learning. Additionally, the business is building a library of AI models for different disease domains (Benkiran, 2023).

Wearable Tech Integration

Pharma businesses are now able to do more than just produce, distribute, and sell medications thanks to wearable tech integration. Patients now have more control over how they treat their ailments and make important decisions thanks to technology. Doctors can already monitor blood pressure, glucose, and other vital signs while keeping an eye on chronic illnesses like diabetes and asthma thanks to a variety of remote patient monitoring devices that are now available (Munos *et al.,* 2016). A Japanese pharmaceutical company called Daiichi-Sankyo and Partners HealthCare Centre collaborated to introduce wearable technology. The two organizations developed a tool known as "the mobile wrap-around," which provides physicians with patient feedback while monitoring patients with atrial fibrillation. Another pioneer in the incorporation of wearable technology is Roche (Oyama *et al.,* 2023). Through the company's integration of the Sugar app with the Accu-Chek Guide glucose meter, individuals with diabetes may now manage their condition in a novel and more sensitive manner. Patients may monitor their blood sugar levels by using the gadget to log in and complete easy activities. The method is distinct, useful, and efficient; it provides patients with a better experience than idly waiting for responses (Montagnana *et al.,* 2009).

Data Management & Analytics

One of the main obstacles to the commercialization of novel medications is the expense of research and development. For example, it can cost up to billion to produce a new biological drug or chemical molecule. This has the knock-on effect of preventing the proper generation and distribution of therapeutics. Pharma researchers can find and distribute new treatments more quickly by utilizing big data to reduce exploration cycles. Additionally, big data can assist in anticipating a drug's negative effects, hence cutting down on the duration of clinical studies.

Reducing the length of research and development cycles can help patients afford their drugs because these expenses drive up the price of pharmaceuticals (Thapliyal *et al.,* 2021).

Single-Use Processes

Single-use technology, or SUT, is being adopted by more pharmaceutical businesses in their production process. This change is continuing as more industry participants become aware of this technology's amazing benefits. Larger-scale high-tier processes can be facilitated by SUTpowered bioreactors. Furthermore, the technique facilitates the production of more dependable goods, doing away with the requirement for container

sterilization. Pharmaceutical businesses that have previously used SUT report streamlined operations, faster turnaround times, and fewer maintenance procedures. In contrast to stainless installations, which might take several days, equipment operating on SUT is simple to set up, needing only one or two hours. Singleuse procedures make it easier to maintain a sterile manufacturing environment by lowering the chance of product cross-contamination (Lopes, 2015).

Precision Medicine

A fresh method for diagnosing, treating, and preventing disease is provided by precision medicine. With the use of this technology, physicians may make precise, fact-based judgments by utilizing their patient's DNA and lifestyle. The recent success of targeted medicines is largely responsible for this rise. Precision medicine has the potential to completely transform cancer by enabling individualized care for each patient. Precision medicine will need to be implemented with a new clinical, technical, financial, and regulatory framework. Doctors may then provide the appropriate therapy to the appropriate patient at the appropriate time (Denicolai & Previtali, 2020).

Bio-printing

The pharmaceutical sector still faces several difficulties with clinical testing. Because there isn't a better way, companies utilize live individuals in clinical studies to assess a drug's safety and efficacy. Nevertheless, that is going to change because of bio-printing. Bioprinting, a huge advancement in health technology that seems like it was taken from out of a dystopian film script, employs methods similar to 3D printing to generate replicas of real human tissue and organs. With this method, a structure resembling a mesh is created by combining cells, growth agents, and other biomaterials. During clinical studies, these 3D-printed organs may be used in place of real human participants. The main material used to manufacture 3D-printed organs, bio-ink, is a liquid suspension of living cells that can assist researchers in producing human tissue in the lab (Koçak *et al.,* 2021).

“In-Silico” Testing

Cosmetics product development is expensive and time-consuming, particularly when businesses are trying to find novel components. In-silico screening is now being used by more businesses to address these production issues. The potent technology makes it simpler to find new active chemicals, which may assist direct the creation of beauty products, by utilizing virtual modelling and molecular databases. Databases and simulation software that record molecular details and interactions with proteins interface with in silico screening methods. In pharmacology, in-silico screening can demonstrate the

interactions between a putative cancercausing chemical and cancer-processing protein (Valerio, 2009). In silico screening has a wide variety of potential applications as it may assist industries dependent on biological research, such as drug and cosmetic development and food toxicity research, in achieving the stated goals: • Make current goods better • Direct product development and other prospective R&D activities; • Determine potential active molecules for a given target and vice versa;

Real-World Data

One of the new developments in pharmaceutical health techniques that is essential to healthcare decisions is real-world data (RWD). Before making regulatory judgments, the U.S. Food and Drug Administration (FDA) for example, combines real-world evidence (RWE) with riskbased data (RWD) to assess a product's safety and discover adverse occurrences. These two technologies are used by medical practitioners to support coverage choices and provide standards for medical instruments used in clinical settings. RWD and RWE are also used by medical product producers to assist clinical trial designs such as big simple studies and pragmatic clinical trials. RWD and RWE are also being used by the developers to assist novel treatment plans and observational research. The medical field may analyse data and apply the findings to enhance the approval and development of new products thanks to the analytical power and sophistication of RWD and RWE. Health data is gathered and stored by wearable, computers, biosensors, and mobile devices. Healthcare workers may then use this data to better plan and carry out clinical a study, which helps provide answers to issues that were previously considered to be unanswerable (Wise *et al.,* 2018)

Challenges arise after the implementation of advanced techniques.

Pharma health technology has its share of problems even if it can revolutionize the pharmaceutical industry. Technology and medicine are two different industries, with their own cultures and ways of doing things. The health community as a whole is used to long development processes and an organized work environment. For example, it might take years to create a new treatment and then go through clinical trials before the drug is released. On the other hand, technology businesses frequently release products and refine them later, working in a fast-paced setting with agile, cross-functional teams. Combining the two sectors is difficult due to their different modes of operation, but it is essential for the development of new healthcare initiatives and the success of health technology businesses (Siyal *et al.,* 2019)

Here's a look at the challenges facing pharma health tech right now:

Threats to Cybersecurity

Cyber-attacks are very common in the pharmaceutical sector. The industry is at the forefront of the data threat environment due to its inventiveness, significant investment in R&D, and intellectual property related to patient health data. Moreover, pharmaceutical companies are receiving more attention than ever before due to the present rate of innovation. As a result, businesses need to reduce both internal and external risks. Businesses may protect information and preserve data privacy by putting the appropriate measures in place, such as employee education and awareness campaigns (Jamil *et al.,* 2019).

Integrity of the Supply Chain

The healthcare industry's supply chain is becoming more digital as pharmaceutical health method changes continue. The advancements need a more dynamic understanding of the supply chain logistics of gene and cell treatments. Pharmaceutical firms must, for example, decide how effectively to deliver these treatments and preserve critical temperatures. Because the medications are costly and life-saving, the supply chain must be flawless (Jamil *et al.,* 2019). To guarantee supply chain integrity, pharmaceutical businesses should implement a strong digital network infrastructure. In this manner, institutions, scholars, and other stakeholders may exchange data and concepts for enhancing product effectiveness.

Integration of IT

Keeping up with regulations is difficult since the pharmaceutical sector depends so much on IT systems for efficiency and growth. Laws evolve in tandem with technological advancements. As a result, businesses struggle mightily to keep abreast of advancements in manufacturing techniques. Profit margins are the primary concern for biopharmaceutical businesses, and the sector is rife with mergers and acquisitions. Because of this, a lot of businesses find it difficult to strike a balance between quick IT integration and high-quality goods and procedures. The pharmaceutical business also has a skills deficit in IT (Qureshi *et al.,* 2017).

Changing Technology

Pharmaceutical field firms may find themselves a more modern, up-to-date solution, even with the incorporation of the latest technical breakthroughs. Pharmaceutical fields firms cannot afford to lag in technology in an industry driven by innovation.

Ending remarks

The COVID-19 epidemic did serve as a wake-up call for the pharmaceutical and healthcare industries if there is one bright spot. Pharma and healthcare businesses are now re-evaluating their workflows and ways to increase productivity. Businesses must first contribute to resolving current business difficulties. To create a strong foundation for cyber resilience and make sure you have the necessary people in place to drive a successful digital transformation (Aghila Rani *et al.,* 2021). Technology advancements and the regulatory framework for customized healthcare are driving a rapid evolution of modern prescription practices. These bring substantial advantages in terms of treatment, cost savings, and patient safety. On the other hand, criticisms and difficulties about technology-integrated complexity must be addressed. Prescription practices of the future will depend on utilizing state-of-the-art technologies, improving patient involvement, and fostering international cooperation to guarantee drug management that is both safe and individualized. Prescription mistakes are a major problem in healthcare and have the potential to seriously injure patients. They can happen at any point during the pharmaceutical process, including during the writing, dispensing, administering, and monitoring phases. Improvements in healthcare and medicines have greatly raised people's quality of life and increased the effectiveness of medical care. This development can be examined in terms of how it affects patient care, diagnosis, treatment, and the entire healthcare process. Artificial intelligence (AI)-driven solutions in digital health care technology enable faster and more accurate analysis of medical images and data than a physician. Additionally, it aids in tailored patient care and predictive analysis concerning disease epidemics. Numerous diagnostic tool types offer higher resolution images, which aid in timely and precise diagnosis and make it possible to see the biological process. This procedure makes it possible for contemporary prescriptions to include this kind of recently approved drug therapy for improvement. Personalized medicine is an innovative approach to healthcare that customizes pharmaceutical regimens to meet the unique needs of individual patients. The identification of biomarkers that predict risk and the course of treatment, as well as the utilization of genomic data for understanding the biology of the disease and how individual variation affects the therapeutic response. Through the use of bio-inks made of living cells and growth factors, bioprinting creates three-dimensional structures. This technology has the power to completely transform a variety of fields, including drug development and tissue engineering. Its capacity to produce sophisticated, functional organs and tissues on demand presents a viable answer to several medical

problems. In silico testing is a potent, far more efficient, and successful technique for drug development. The usability and influence of the *In-silico* Method are expected to be enhanced by ongoing technological advancements, notwithstanding obstacles to contemporary accuracy and regulatory approval. Real-world data can change healthcare by offering thorough, fast, and generable insights regarding patient outcomes, treatment efficacy, and healthcare practices.

Conclusion:

Modernizing the prescription procedure is a major step towards improving patient care and health care efficiency. Prescription management has changed as a result of advancements including computerized prescribing, telephonic consultations, and wearable devices for digital health records. A complex approach is required to deal with prescription errors, including education, technology, communication, and promoting a culture of safety within healthcare organizations. By effectively assessing prescription errors and preventing them, patients may be better protected from harm and have greater overall medication safety. These innovations improve communication between healthcare providers and patients while streamlining workflows and lowering error rates. They also make medication more accessible and encourage better adherence to the prescribed course of therapy. Promoting patient privacy and data security is essential as we continue to embrace technological advancements. Modernization's power can guarantee greater adherence to the healthcare facility and improved connectivity.

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THE PROBIOTICS AND PREBIOTICS IN CASE OF FOODS

Sayed Rizwan A.

Sir Sayyed Collge of Arts, Commerce and Science,

Aurangabad 431 001, Maharashtra

Corresponding author E-mail: sayedra31@gmail.com

Introduction:

Probiotics are live microorganisms that have multiple functions effects on the human and body by maintaining the precise balance of desirable and undesirable bacteria in the human digestive system (Fuller, 1992). Probiotics creates self care and food system integrated medicines, links between diet and health. Probiotics foods are functional foods as they promote health beyond providing basic nutrition. Some of the recent development in probiotic foods are discussed below:

1. Types of Probiotics:

These are numerous species of lactobacilli and biofidobacteira. The mais spcies thought to have probiotic characteristics are *L. casei, B. subtilis, L. Johnsoni, L bulgaricus, L. rhamnousus, I returi, L. acidophilus, B. lactis, B. breve, B. animalis, infanitis* and *B. longum.* Commercially so far 10 species of lactobacilli with total 56 strains and 9 species of boifidobacteria having 29 strains a have been reported in use (Shah, 2001).

2. Needs of Probiotics:

We come in contact with disease causing bacteria. Which are responsible for human diseases? Probiotics protects us from diseases caused by "unfriendly" organisms by out populating and inhibiting the growth of unfriendly micro-organisms (2) replacing "good" bacteria killed by antibiotics (3) manufacturing chemicals absorbet into the body that the immune system uses to control the bad microorganisms.

3. Criteria for Probiotics:

While selecting the strains of bacteria, as an probiotics, following criteria's are to be considered.

Probiotic strains should be representative of microorganisms that are Generally Recognised As Safe (GRAS). It should be stable in gastric acid and bile probiotic strain should not exhibit any pathogenic, toxic, allergic, mutagenic or carcinogenic reactions. They should be capable of reviving and metabolizing in the gut environment. They should be easy to culture (adherence to human intestinal calls and colonization). They should be viable during processing and storage. They should be capable of producing beneficial effect on consumer.

4. Susceptibility of Probiotics

Probiotics are susceptible to environmental conditions such as water, oxygen, light, processing and acid and salt conditions (pH), collectively affect the viability. Processing such as sterilization, pasteurization, microwave treatment, retorting, disinfection, irradiation and washing destroy probiotic organisms.

5. Technology to Imrpve Survivability of Probiotics Organisms

The survival of probiotics in intestine can be increased by various ways or the functions are enhanced either, 1) Freeze drying 2) probiotech (Polysaccharide coating), live Bac (micro-encapsulation), bio-tract (Programmed release of active ingredients). Probiocap (coating and entrapping it in a matrix of food grade vegetable fatty acids, Canadian Patent).

6. Health Benefits of Probiotics:

The health benefits of probiotics are widely recognized today. Some of these are listed below

- Improve the intestinal microbial balance
- Produces lactose
- Strengthen the immune system
- Reduces the colon cancer in human
- Helps in treatment of food allergies
- Lowers the blood cholesterol levels
- Reduces the blood pressure in hypertension
- Play key role in prevention and treatment of diarrhoea caused by rotaviruses.
- May directly inhibit the pathogenic bacteria in the intenstive by competing for nutrients and space.

7. Compounds of Probiotics and Their Effects:

The different biochemical compounds are synthesized by the microorganisms which acts as probiotics some of these are listed for their role:

1. Organic Acids

Lactic acid and acetic acid (90 %), lowers the pH and exert the bactericidal or bacteriostatic effect.

2. Antimutagenic Acetivity:

Binding of acid molecules i.e. acetic acid with mutagens. Butric acid showed broad spectrum antimutagenic activity (4-nitroquinoline N-oxide, 2. nitrofluorene and benzopyrene).

3. Reduction in Serum Cholesterol Level:

The role of bifidobacteria in reducing cholesterol level from 3.0 to 1.5 g/l is not completely understood. This may be due to production of hydroxyl methyl glutavate, which inhibit hydroxyl methyl glutaryl-Co-A reductase required for synthesis of cholesterol (Gilliland *et al.,* 1985).

4. Immunomodulation:

It is not clearly understood. However probiotic food (yoghurt) stimulate cytokine production in blood cells and enhance the activities of macrophages (Marteau *et al.,* 1997).

5. Natural Antibiotics:

Acidophilin, acidoin, bulgaricin and plantaricin (bacteriocines), are produced during the growth of probiotics.

6. Probiotic Products in Market and in Human Consumption

Currently bifidus and acidophilus bacteria, containing products are reported world wide. More than 53 different types of probiotics products are marketed in Japan (Hilliam, 2000), in future, probiotic products such as energy bars, cereals, juices, cheeses likely to be marketed.

Compounds of Probiotics and Their Effects

Organic acids	Organic Lactic acids and acetic acid (90%) lowers the pH and exert bacteriocidal or bacteriostatic effect.
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Natural Antibiotics	Acidophilin acidoin, bulgaricin and plantaricin (bacteriocins)

Yogurt and sour milk products are well known examples in Western society as probiotic foods. The same beneficial effects can be expected from African cereal gruels like ogi and ugi, Nigerian garis and Asian vegetable foods like dhamuoi in Vietnam, dakguadong

in Thailand and burong mustard in Philipnes and fermented sea foods mixed with cereals (Lee, 1994). In addition to probiotic effect, vegetable products have excellent prebiotic functions.

Using milk and cereals or soya a type of fusion food like rice yohurt and soya yogurt could be prepared. Risoguri, a fermented drink using soya protein and cereals is studied in Korea (Mok, 1994).

Soyabean fermentation from soyabean sauce and paste, Korean chong kukjang and Japanese Natto production involves the process of enzymatic hydrolysis of protein to make peptides and amino acids. Some peptides in soybean source and paste are known to have ACE inhibition, antithrombiotic and ant cancer effect (Shin *et al.,* 1995).

7. Safety Considerations

Probiotics may responsible for four types of side effects (Marteau, 2002).

1. Systemic and infections
2. Deleterious metabolic activities
3. Excessive immune stimulation in susceptible individuals
4. Gene transfer.

Documented correlations are few and occurred in the patients with underlying medical conditions.

Producer has to prove any given probiotic strain is not a significant risk with regard to transferable antibiotic resistance.

8. Evaluation of Probiotics

Criteria for status of probiotics set by FAO/WHO is as below.

- The probiotic effects are strain specific
- Strain identify link to a specitic health effects/benefits
- Nomenclature of the bacteria must confirm to the current, scientifically recognized names on product labels.
- DNA DNA hybridization is the method to specify strain
- Strain typing is to be performed with a reproducible genetic method or phenotypic trait.
- All strain should be deposited in an internationally recognized culture collection.
- Currently used invitro tests are: Resistance to gastric acidity and Bile acid resistance
- Adherance to mucus and/or to human epithelial cell and cell lines.
- Antimicrobial activity against potential pathogens.

- Ability to reduce pathogen adhesion to surface.
- Bile salt hydrolase activity

Food Sources of Probiotics

1. Tempeh
2. Butter milk
3. Yoghurt
4. Kefir
5. Kimchi
6. Sauerkraut
7. Other "Fermented" foods.

Prebiotics

Prebiotics are compounds in food that foster growth or activity of beneficial microorganisms such as bacteria and fungi.[1] The most common environment considered is the gastrointestinal tract, where prebiotics can alter the composition of organisms in the gut microbiome.

Dietary prebiotics are typically nondigestible fiber compounds that pass undigested through the upper part of the gastrointestinal tract and help growth or activity of advantageous bacteria in the colon by acting as substrates for them.[1] They were first identified and named by Marcel Roberfroid in 1995.[1][2] Depending on the jurisdiction, they may have regulatory scrutiny as food additives for the health claims made for marketing purposes. Common prebiotics used in food manufacturing include beta-glucan from oats, resistant starch from grains and beans, and inulin from chicory root.

Definition

The definition of prebiotics and the food ingredients that can fall under this classification, has evolved since its first definition in 1995.[3] In its earliest definition, the term prebiotics was used to refer to non-digestible food ingredients that were beneficial to the host through their selective stimulation of specific bacteria within the colon.[3][4] Further research has suggested that selective stimulation has not been scientifically demonstrated.[5] As a result of research suggesting that prebiotics could impact microorganisms outside of the colon, in 2016 the International Scientific Association for Probiotics and Prebiotics (ISAPP) produced the following definition of prebiotics: a substrate that is selectively used by a host microorganism to produce a health

benefit.[3] In 2021, The Global Prebiotic Association (GPA) defined a prebiotic as a product or ingredient that is utilized in the microbiota producing a health or performance benefit.[6] Compounds that can be classified as prebiotics must also meet the following criteria:[3][4][6]

- Non-digestible and resistant to breakdown by stomach acid and enzymes in the human gastrointestinal tract
- Fermented by microorganisms on or in the body
- Stimulating growth and activity of beneficial bacteria

Thus, consumption of prebiotics may facilitate the health of the host.[7] Based on the previous classifications, plant-derived carbohydrate compounds called oligosaccharides as well as resistant starch are the main source of prebiotics that have been identified.[8][4][9][10] Specifically, fructans and galactans are two oligosaccharide sources which have been found to stimulate the activity and growth of beneficial bacterial colonies in the gut.[7][3] Fructans are a category of carbohydrate consisting of fructooligosaccharides (FOS) and inulins, while galactans consist of galactooligosaccharides.[3] Resistant starch has been shown to shift the intestinal bacteria, as well as improve biomarkers for numerous health conditions.[11][12][13] Other dietary fibers also fit the definition of prebiotics, such as pectin,[14] beta-glucans,[15] and xylooligosaccharides.[16]

The European Food Safety Authority (EFSA), the regulatory agency for product labeling, differentiates between "prebiotic" and "dietary fiber", stating that "a cause and effect relationship has not been established between the consumption of the food constituents which are the subject of the health claims and a beneficial physiological effect related to increasing numbers of gastrointestinal microbiota".[17] Consequently, under EFSA rules individual ingredients cannot be labeled as prebiotics, but only as dietary fiber and with no implication of health benefits.[17]

Function

When the prebiotic concept was first introduced in 1995, the primary focus was on the effects that prebiotics confer on *Bifidobacteria* and *Lactobacillus.*[3][4][18] With improved mechanistic techniques in recent years, the current prebiotic targets have expanded to a wider range of microbes, including *Roseburia* spp., *Eubacterium* spp., *Akkermansia* spp., *Christensenella* spp., *Propionibacterium* spp. and *Faecalibacterium* spp.[19] These bacteria have been highlighted as key probiotics and beneficial gut bacteria as they may have several beneficial effects on the host in terms of improving digestion (including but not

limited to enhancing mineral absorption)[20] and the effectiveness and intrinsic strength of the immune system.[21] Both *Bifidobacteria* and *Lactobacillus* have been shown to have differing prebiotic specificity and to selectively ferment prebiotic fiber based on the enzymes characteristic of the bacterial population.**[22]** Thus, *Lactobacilli* prefer inulin and fructooligosaccharides, while *Bifidobacteria* display specificity for inulin, fructooligosaccharides, xylooligosaccharides and galactooligosaccharides.[22] Studies have also shown that prebiotics, besides helping growth of beneficial gut bacteria, can also inhibit detrimental and potentially pathogenic microbes in the gut,[9][4] such as clostridia.[4]

Mechanism of Action

Fermentation is the main mechanism of action by which prebiotics are used by beneficial bacteria in the colon.[7][4] Both *Bifidobacteria* and *Lactobacillus* are bacterial populations which use saccharolytic metabolism to break down substrates.[4] The bifidobacterial genome contains many genes that encode for carbohydrate-modifying enzymes as well as genes that encode for carbohydrate uptake proteins. The presence of these genes indicates that *Bifidobacteria* contain specific metabolic pathways specialized for the fermentation and metabolism of plant-derived oligosaccharides, or prebiotics. These pathways in *Bifidobacteria* ultimately produce short chain fatty acids,[4][7] which have diverse physiological roles in body functions.[23][3]

Sources

Prebiotic sources must be proven to confer a benefit to the host in order to be classified as a prebiotic.[3] Fermentable carbohydrates derived from fructans and xylans are one well documented example of prebiotics.[3] Resistant starch from starchy foods are also well documented prebiotics and have historically been the highest source of prebiotics in the diet, as 4-10% of starch in mixed diets has been shown to reach the large intestine.[24] One study reported that individuals consuming a traditional diet in Africa consumed 38 grams of resistant starch/day.[25]

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VALONIOPSIS PACHYNEMA - A THERAPEUTICALLY POTENTIAL SEAWEED FOR AILMENTS

R. Pavithra, S. Sanjupriya and M. Poonkothai*

Department of Zoology,

Avinashilingam Institute for Home Science and Higher Education for Women,

Coimbatore - 641 043, Tamil Nadu, India

*Corresponding author E-mail: poonkothaii_zoo@avinuty.ac.in

Abstract:

Seaweeds are multi-cellular photosynthetic organisms, usually referred to as marine macroalgae. They mainly possess growth-promoting phytohormones, cytokinins, auxins, gibberellins, antibiotics, trace elements, vitamins, amino acids, micro and macronutrients. The green seaweed *Valoniopsis pachynema* is rich in carbohydrates, proteins, and other macronutrients. It may grow dominantly on intertidal rocks and dead corals compared to other green seaweeds. Due to rich nutrients, *V. pachynema* can be exhibited as a potential seaweed for supplementing nutrients. Seaweed possesses nutritional properties attributed to its phytochemicals and may be valued in the pharmaceutical industry. Hence this paper allows researchers to investigate further the multi-utility potentiality of *Valoniopsis pachynema* for various biomedical applications.

Keywords: *Valoniopsis pachynema,* Phytochemistry and Therapeutics.

Introduction:

Seaweeds are one of the large and diverse ecosystems, and it plays an essential role in the marine environment. Seaweeds are multi-cellular photosynthetic organisms, usually referred to as macroalgae. Marine algae are classified as red algae (Rhodophyta), brown algae (Phaeophyta), and Green algae (Chlorophyta). Seaweeds have been a food source for humans since ancient times. Seaweeds are commonly consumed as either fresh or dried in Asian, African, and European countries, and the consumption of seaweed as food products can be traced back to the fourth century in Japan. Seaweeds are rich in vitamins A, E, C, B_1, B_{12}, carbohydrates, and organic iodine. In addition to their nutritive value, seaweeds possess a wide array of valuable pharmacological properties, including antibiotics, anticoagulants, antiulcer, antioxidants, antimicrobials, and antifouling. The green seaweed *Valoniopsis pachynema* is rich in carbohydrates, proteins, and other macronutrients such as calcium, sodium, potassium, phosphate, high cellulose content, and other vital minerals

(Kaliaperumal *et al.,* 2002 and Ji *et al.,* 2009). *Valoniopsis pachynema* is a heterogeneous group of organisms with considerable metabolic diversities. It includes sterols, isoprenoids, terpenoids, steroids, phenolic compounds, fatty acids, acrylic acid, and alkaloids. It is also an antimicrobial, anticancer, antioxidant, antiviral, anti-inflammatory, anti-emetic activity, wound healing, and neuroprotective compound. According to the latest findings, *V. pachynema* contains higher biochemicals, vitamins, and minerals, and this green marine algae's secondary metabolites have optimistic anti-inflammatory properties. Hence, *V. pachynema* possesses valuable therapeutic effects, supplements nutrients, and can act as an alternative to cure various ailments or diseases.

Scientific classification of *Valoniopsis pachynema*

Kingdom : Plantae
Phylum : Chlorophyta
Class : Ulvophyceae
Order : Cladophorales
Family : Valoniaceae
Genus : *Valoniopsis*
Species : *pachynema*

Morphology of *Valoniopsis pachynema*

Valoniopsis pachynema (G. Martens), commonly known as AstroTurf, is a filamentous green alga. It forms stiff, spongy mats with tangled branched filaments on dead corals, intertidal rocks, and other rigid substrates. This alga ranges in colour from yellowish-green to bright or dark green and creates large pad-like formations up to 20 cm in diameter and 2-3 cm thick. It often covers substrates in a ball-like appearance and can form small, green, hairy clumps when growing on dead reefs. These cushion-like clumps typically measure about 2-5 cm wide. The thallus is filamentous or branched, forming dense aggregations of green or dark green, with irregular and curved terminal branches. The alga attaches to substrates through a rhizoidal structure (Titlyanov *et al.,* 2017).

Distribution

The Astro-turf alga, *Valoniopsis pachynema*, thrives in the lower littoral zones, preferring rocky substrates with high wave action and is prevalent in tropical seas. It grows year-round and is often found washed ashore in the Palk Bay and Gulf of Mannar regions of India. This commercially unexploited green seaweed is abundant in North, Central, and South America, Atlantic islands, Africa, Indian Ocean islands, Asia, Australia, the Gulf of

California, the West Indies, Mauritius, Sri Lanka, India, Pakistan, Spain, Pacific islands, and New Zealand. In India, moderate growth of this alga is observed from September to April on the west coast (Jha *et al.,* 2009), and other green seaweeds from September to November on the southeast coast (Kaliaperumal and Kalimuthu, 1997).

Therapeutic Potential of *Valoniopsis pachynema*

Phytochemical Constituents of *Valoniopsis pachynema*

Dhinakaran *et al.* (2016) reported the pharmacognostic descriptions of the extract of *Valoniopsis pachynema* and *Sargassum swartzii*. Preliminary phytochemical analyses indicated the existence of terpenoids, phenols, flavonoids, saponins, alkaloids, phytosterols, and steroids. The results were applicable in setting pharmacognostic purity, consistency, and preparation standards. Dhinakaran *et al.* (2015) evaluated the total phenolic content from the extract of *V. pachynema* which exhibited maximum activity (50µg/ml) as compared with *Sargassum swartzii*.

Antimicrobial Activity

Dhinakaran *et al.* (2016) performed the antimicrobial activity with an aqueous extract of *Valoniopsis pachynema* using various bacterial isolates (*Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli, Klebsiella pnuemoniae, and Bacillus subtilis*) and fungal isolates (*Aspergillus niger and Penicillin notatum*). The antimicrobial activity aqueous extract of *V. pachynema* exhibited a maximum zone of inhibition in *Pseudomonas aeruginosa, Klebsiella pnuemoniae, Aspergillus niger* and *Penicillium notatum* was found to be susceptible to forms of extracts.

Antioxidant Properties of *Valoniopsis pachynema*

Mahomoodally *et al.* (2020) reported that the extract *of Valoniopsis pachynema* has the highest methanolic content with substantial as radical scavenging activity of 1,1-diphenyl-2-picrylhydrazyl (DPPH), 2,2'-azino-bis 3-ethylbenzothiazoline -6-sulfonic acid (ABTS), reducing power cupric ion reducing activity (CUPRAC) of 25.71±0.73 mg TE/g, ferric reducing antioxidant power (FRAP) of 9.03 ± 0.10 mg TE/g, total antioxidant capacity phosphomolybdenum (PHPD) of 0.30±0.04 mol TE/g and metal chelating power using ferrous ions of 9.05 ± 0.76 mg EDTAE/g.

Kavitha *et al.* (2015) investigated the free radical scavenging activity of the methanolic extract of *Valoniopsis pachynema.* It was measured in terms of DPPH and ABTS and the antioxidant potential was also assessed and compared with commercial antioxidants, such as Butylated Hydroxy Toluene (BHT) and L- ascorbic acid. The results

showed that *V. pachynema* at 500 µg/ml concentration revealed higher DPPH and ABTS. The antioxidant activity of *V. pachynema* showed a dose-dependent increase as compared to commercial antioxidants. The significant free radical scavenging activity of *V. pachynema* might be attributed to the presence of secondary metabolites in the alga.

Kavitha *et al.* (2015) explored the in-vitro antioxidant activity of methanolic extract from the green alga *Valoniopsis pachynema*. The ability of the extract to scavenge superoxide, hydroxyl, and nitric oxide radicals was measured. The antioxidant potential was compared to Butylated Hydroxy Toluene (BHT) and L-ascorbic acid. The algae extract showed a dose-dependent increase in antioxidant activity. The significant antioxidant activity is likely due to the presence of carotenoids, free phenols, and fatty acids in the alga.

Enzymatic Inhibitory Properties of *Valoniopsis pachynema*

Mahomoodally *et al.* (2020) demonstrated that methanolic extract of *V. pachynema* has higher inhibition against α-glucosidase in contrast to α-amylase, acetylcholinesterase (AChE), butyrylcholinesterase (BChE) and tyrosinase when compared to methanolic extract of *Spyridia hypnoides*.

Antiemetic Activity of *Valoniopsis pachynema*

Ahmed *et al.* (2012) explored the antiemetic activity of marine algae, specifically *Valoniopsis pachynema*, in chicks. Through a comprehensive study, the researchers aimed to uncover the potential antiemetic effects of these algae extracts using a chick emesis model. The findings revealed that *Valoniopsis pachynema* extract demonstrated significant antiemetic properties and displaying a notable 24.39% inhibition of emesis. This suggests that marine algae could hold promise as natural antiemetic agents, potentially offering new avenues for antiemetic treatment strategies.

Nutritional Composition of *Valoniopsis pachynema*

Kumar *et al.* (2010) reported that *Valoniopsis pachynema* contains a high quantity of total macronutrients, ranging from about 943.74%. It also has a significant calcium content of approximately 477%, essential for bone and teeth formation, blood clotting, and the proper functioning of nerves and muscles. Calcium acts as a cofactor for extracellular enzymes and proteins.

Ito and Hori (1989) found that *Valoniopsis pachynema* has a presence of 104% and is rich in amino acids such as thiamine and biotin. These amino acids are crucial for developmental and neurological processes, collagen synthesis, detoxification, improved blood circulation, and reduced muscle cramping and back pain. They also help alleviate

inflammation, aid in muscle healing, support the liver in producing choline (an essential nutrient for nerves and the myelin sheath), stimulate bile flow, regulate heart and brain function, promote healthy skin, nails, and hair, and lubricate joints.

Other Activities

Lakshmikandan *et al.* (2020) explained that research conducted on dilute acid hydrolysate of seaweed *V. pachynema* extract was used to culture the microalgae along with control and aqueous treated seaweed liquid extract. The results showed that the seaweed acid hydrolysate has moderate growth compared to the control medium (ACM) and indicated that acid hydrolysate can elevate the growth of microalgae compared to aqueous extract. The combination of ACM and seaweed acid hydrolysate significantly increased biomass yield and lipid productivity.

Sunesh *et al.* (2024) focused his study on extracting micro-sized cellulose filler from the green algae *Valoniopsis pachynema* to enhance bio-based films for food packaging. *V. pachynema* algae has a density of 0.54 g/cc and contains 6.01% cellulose. Acid hydrolysis is used to separate the insoluble cellulose component effectively. X-ray diffraction analysis reveals semicrystalline structures with a crystallinity index of 71.9% and a crystallinity size of 69.81 nm. Fourier transform infrared spectroscopy and Raman spectra confirm the presence of cellulose functional groups in the algae. Thermogravimetric analysis shows the onset temperature of cellulose degradation at 290°C, with an activation energy of 55.93 kJ/mol. Atomic force microscopy measures surface roughness (Ra value) at 33.925 μm. Scanning electron microscopy determines the cellulose size, revealing an aspect ratio of less than 3. The extracted microcrystalline cellulose is used as a filler in polylactic acid (PLA) to prepare bio-based films.

Lakshmikandan and Murugesan (2016) investigated photobiological hydrogen production by *Chlorella vulgaris* MSU-AGM 14, utilizing *Valoniopsis pachynema* seaweed extract as a carbon and nitrogen source. *C. vulgaris* was isolated from pond water and tested for its ability to produce biohydrogen under anaerobic and sulfur-depleted conditions with 15 mmol photons m^2/s light. Seaweed extract concentrations were ranged from 10% to 100% with enhanced growth and hydrogen production. Optimal conditions were determined using Response Surface Methodology (RSM) with 22.5% extract, pH 6.8, 32°C, and 5% CO_2. Biohydrogen production was quantified via Gas Chromatography (GC) where 16S rRNA analysis identified a 609 bp fragment in *C. vulgaris*, consistent with the *Chlorella beijerinck* genus.

Sanandiya *et al.* (2016) evaluated the cellulose extracted from *Valoniopsis pachynema*, an underutilized green seaweed from Indian waters, for its microcrystalline properties and potential in paper making. The crude cellulose from *V. pachynema* has a high crystallinity of 95%, comparable to commercially available microcrystalline cellulose like HiCel™ (91% crystallinity). Paper made from this seaweed cellulose pulp exhibited chemical and strength properties, particularly high tear resistance, similar to non-wood pulps (soft wood and bamboo) but inferior to wood pulps. The seaweed pulp can be used in paper production by blending it with other pulps. Given its high-quality cellulose, *V. pachynema* can be exploited as a new source of cellulose with practical applications.

Conclusion:

Valoniopsis pachynema, historically utilized as a food source, has garnered recent scientific attention primarily for its antioxidant capabilities, corrosion inhibition properties, potential in papermaking, and role in biohydrogen production. Despite these applications, comprehensive studies on this green seaweed are still lacking, particularly concerning detailed chemical compositions and pharmacological profiles that could highlight its therapeutic benefits with minimal or no side effects. Many of its potential therapeutic activities remain undiscovered.

Nevertheless, *Valoniopsis pachynema* stands out as a versatile marine organism with significant prospects in therapeutic, nutritional, and industrial domains. Further research aimed at exploring and developing its bioactive compounds and functional properties holds promise for making substantial contributions to healthcare, pharmaceuticals, and the field of sustainable materials science. By unlocking its full potential, this seaweed could offer novel solutions that benefit both human health and environmental sustainability.

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PROBIOTICS: AN ELIXIR TO HUMAN LIFE

Suraj Dipak Gabale* and Shweta Arvind Pise

Department of Microbiology,

Vivekanand College, Kolhapur (Empowered Autonomous), M. S.

*Corresponding author E-mail: surajgabale10@gmail.com

Introduction:

The probiotics are live microorganisms that have health benefits when consumed or applied to the body. These are food supplements that contain live bacteria and yeasts that have beneficial effects, especially on digestive system.

Probiotics are a certain type of friendly microorganisms, provides health benefits when eaten. Probiotics are considered generally safe to consume, but may cause bacteria host interactions and unwanted side effects in certain rare conditions. The word probiotic comes from Greek word pro meaning "promoting" and biotic meaning "life".

The probiotic foods include yogurt, kefir, sauerkraut, tempeh, kimchi etc. The most common probiotic bacteria are *Lactobacillus* and *Bifidobacteria*. Other common kinds are *Saccharomyces, Streptococcus, Enterococcus, Eishcherichia* and *Bacillus*. Each genus comprises different species and each species has many strains.

Probiotic Products:

The probiotic products contain selective and beneficial types of microbes to add to the populations already living in our body. Many probiotics are oral supplements designated to be ingested into gastrointestinal tract. Others are topical products that can be applied to skin or mucous membrane of nose or genitals.

Following are some examples of probiotic products:

1. Yoghurt:

It is one of the best source of probiotics, which have friendly bacteria those can improve your health. Eating yoghurt is associated with various health benefits, including bone health and reduces high blood pressure. It can reduce diarrhoea caused by antibiotics in children. It can also relieve symptoms of irritable bowel syndrome. It is a good option for people with lactose intolerance.

2. Sauerkraut:

It is a finely cut cabbage that has been fermented by various lactic acid bacteria and preserved in salted juice. It is either served directly with sauerkraut and mashed potatoes

or stored in refrigerator for later use. It has long shelf life and distinctive sour flavour, which is a result of lactic acid formed when bacteria ferment the sugars in the cabbage leaves. The Sauerkraut have been associated with many health benefits like it improves digestion and promote the growth of normal flora of intestine, protects against the diseases of digestive tract. It is rich in vitamin C and K. It is high in calcium and magnesium.

3. Kimchi:

Kimchi is a traditional Korean dish made with salted fermented vegetables. The cabbage is the main ingredients of kimchi. It is good for digestive health and has lactic acid bacteria *Lactobacillus kimchii.*It is vitamin K, which helps in blood clotting and also keeps bones from becoming brittle.

4. Kefir:

Kefir is a type of fermented milk that may helps to manage blood sugar, lowers cholesterol and boosts digestive health. Kefir has tangy flavour and a consistency similar to drinkable yoghurt. It is rich in vitamins and minerals.

5. Kombucha:

It is a fermented black or green tea. It is made by adding specific strains of bacteria, yeast and sugar to black or green tea and then allowing it to ferment for a week or more. Kombucha contains antioxidants, can kill harmful bacteria and may help fight several diseases. It may also improve many aspects of health, including digestion, inflammation and even weight loss.

Status of Probiotic in India

Traditional Indian diet contains many fermented foods that have natural probiotic microorganisms. Diversity of Indian fermented foods is related to unparallel food culture of India. In India probiotics is also used as animal feed supplements for cattle, poultry and piggery as an alternative to antibiotics.

Indian drink including lassi have predominant *Lactobacillus* and *Lactococcus* as fermenting organism but also depends upon the type of preparation techniques. Some of the Indian non-dairy probiotic drinks are made from grains, fruits, legumes and vegetables have also have gained more popularity due to health concerns for cholesterol or lactose intolerance. In India probiotics is also used as animal feed supplements for cattle, poultry and piggery.

More than 1000 types of fermented foods and beverages are produced naturally or by adding microbial cultures in India.

Dairy based probiotic beverages consumed in India	
Drink	**Microorganisms involved**
Dahi	*Enterococcus faecalis, E. faecium, Lactococcus lactis, Lactobacillus rhamnosus*
Buttermilk	*Lactococcus lactis, Lactococcus*
Mar	*Lactococcus lactis, Lactobacillus helveticus, Acetobacter* spp., *Gluconobacter* spp.
Churapi	*Lactococcus lactis, Lactobacillus fermentum, Acetobacter* spp., *Gluconobacter* spp.
Gheu	*Lactococcus lactis, Lactobacillus helveticus, Acetobacter* spp., *Gluconobacter* spp.
Kanji	*Lactococcus plantarum*

Health Benefits of Probiotics

1. Improves Nutritional Absorption:

Around 90 percent of nutrients are absorbed in small intestine. So, it is necessary to maintain proper balance of gut microorganisms. This is where probiotic organisms breakdown food into nutrients that can be used by body

2. Prevent and Treat Diarrhoea:

Many antibiotics can negatively affect the balance of good and bad bacteria in the gut. Several studies suggest that, probiotic used is responsible for reducing the risk of diarrhoea associated with antibiotics. It can also help with other forms of diarrhoea which are not associated with antibiotics.

3. Improves Mental Health:

It is been observed that, the probiotic products can improve some mental health disorders. Researchers have shown that mental disorders can be linked to poor gut bacteria. Digestive discomfort caused by disturbance to gut bacteria can contribute poor mental health.

4. Helps to Treat Digestive Disorders:

The probiotics can help in reducing the risk of gastrointestinal issues such as gas, bloating and ingestion. An imbalance of ‘good; and ‘bad’ bacteria can cause different disorders. Probiotics can treat such disorders by increasing normal bacteria microflora.

5. Boosts Immune System:

Probiotics have been found to enhance the immunity and also regulates the pathogen induced inflammatory reactions.

6. Reduces Risk of Chronic Diseases:

Due to the role in immune system modulation and the anti-inflammatory the probiotics are now being used to prevent and treat chronic diseases.

Some bacterial strains used in probiotics can play crucial role in maintaining heart health.

Probiotics may reduce the severity of certain allergies and eczema.

Side Effects of Probiotics

Probiotics have many beneficiary roles in human health. But there are some adverse effects of probiotics as well. They can trigger allergic reactions. Sometimes they might be responsible for mild stomach problems, especially in early days of probiotic product consumption. The small risk of adverse effects can be observed in the people with poor immune system, especially in people taking immunosuppressant drugs, critical illness and infants with premature birth.

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AN OVERVIEW OF AXENFELD–RIEGER SYNDROME (ARS)

Ujjval P. Vaghela*[1], Bhavik Jani[2], Kushal Parekh[2] and Pratik Vediya[2]

[1]Department of Pharmacy,

Sumandeep Vidyapeeth Deemed to be University, Vadodara, Gujarat, India.

[2]School of Pharmacy, RK University, Rajkot, Gujarat, India.

*Corresponding author E-mail: ujjvalvaghela08@gmail.com

Abstract:

Axenfeld-Rieger syndrome is a genetic disorder affecting multiple organ systems. It causes varying degrees of anterior segment dysgenesis in the eyes and increases the risk of glaucoma. The condition is also linked to cardiovascular outflow tract malformations, craniofacial abnormalities, and pituitary dysfunction, which can lead to severe endocrine issues. Molecular genetics have identified mutations in the PITX2 and FOXC1 genes as major contributors to the disease, though other genetic factors may be involved. Effective management requires a multidisciplinary approach to monitor and treat glaucoma, hearing loss, and abnormalities in the cardiac, endocrine, craniofacial, and orthopedic systems. Research indicates that the correct appearance level of the PITX2 gene is essential for its role.

Keywords: Axenfeld-Rieger syndrome, Paired-like homeodomain, Forkhead box protein C1, Paired box protein Pax-6

Introduction:

Axenfeld–Rieger syndrome (ARS) consists of inherited eye disorders with anterior segment malformations present at birth. About 50% of ARS patients develop glaucoma, potentially causing visual-field loss or blindness. ARS also frequently involves defects in the teeth and umbilicus. The severity and presentation of Axenfeld-Rieger syndrome (ARS) can vary widely, even among family members sharing the same transmutation, which complicates disease cataloging, analysis, and pathological training. [1] The first identified defective gene in ARS was PITX2, a homeobox transcription factor. Subsequent research identified additional ARS-related genes such as FOXC1 and PAX6. However, approximately 40% of ARS patients do not exhibit known chromosomal abnormalities or mutations in these genes, suggesting the involvement of additional unidentified genes. Despite this, PITX2 remains the primary gene associated with ARS, impacting both ocular and non-

ocular features. [2] Some unexplained cases of ARS may involve deficiencies in genetic factor products related to the PITX2 trail.

The Axenfeld-Rieger spectrum

The Axenfeld–Rieger group of disorders became recognized as a unified entity following a thorough review by Alward. Previously, these conditions were diagnosed separately under various names like Rieger syndrome, Axenfeld disease, Axenfeld anomaly, Rieger anomaly, iridogoniodysgenesis disease, iridogoniodysgenesis anomaly, familial glaucoma iridogoniodysplasia, and iris hypoplasia are collectively referred to as Axenfeld-Rieger syndrome for several reasons: (1) they share overlapping symptoms previously classified into distinct subgroups; (2) there is wide variation in severity and clinical manifestations both within and between these subgroups; (3) mutations in major genes like PITX2 or FOXC1 are common across multiple subgroups; and (4) there is ongoing debate among physicians regarding consistent diagnosis of abnormal angles in goniodysgenesis. For example, AA was originally distinguished from AS due to its lack of glaucoma, but around 50% of AA patients eventually develop this condition. Individuals affected by ARS display a range of ocular defects, including a visible white or yellowish ring (Schwalbe's line) around the iris during slit-lamp examinations, known as posterior embryotoxon. [3] This feature is also seen in about 15% of the general population in milder forms and may be absent in some cases of RS. In these patients, abnormal angle tissue can cause iridocorneal adhesions. This can lead to underdeveloped (hypoplastic) and disrupted iris, resulting in phenomena such as multiple or displaced pupils and an elongated, cat-like pupil (corectopia). Corneal abnormalities such as thickness, cloudiness, or enlargement (megalocornea) are also observed, indicating increased intraocular pressure—a significant risk factor for glaucoma. Glaucoma itself involves optic nerve head degeneration or damage to retinal ganglion cell layers, potentially leading to blindness if untreated. Glaucoma affects about half of RS patients, with the age of onset varying significantly but typically occurring during adolescence. [4] Dental anomalies are common, with fewer or smaller teeth (hypodontia or microdontia), and complete absence of teeth (anodontia) is severe, often affecting upper incisors disproportionately. Another characteristic of RS is excessive periumbilical skin, sometimes with a protruding umbilical stump, and severe cases may involve omphalocele, a condition where the abdominal wall doesn't close properly, potentially leading to stillbirth. Occasionally, gastrointestinal issues like anteriorly displaced or imperforate anus are observed. Patients with Rieger syndrome (RS)

commonly exhibit a flat midface caused by an underdeveloped upper jaw (maxillary hypoplasia). Occasionally, they may also show pituitary abnormalities like empty sella syndrome, growth hormone insufficiencies leading to growing hindrance, cardiac imperfections, hearing loss, hypospadias, and cognitive impairments. [5] Despite PITX2 being prominently expressed in the pituitary and heart during development, there are no documented cases in the literature where mutations in PITX2 leading to packed range Axenfeld-Rieger syndrome (ARS) have been allied straight to pituitary or heart deficiencies.

Gene Mutations associated with Axenfeld-Rieger Syndrome

The first identification of the ARS chromosomal locus, 4q25, was achieved through cytological studies and linkage analysis. Later, the PITX2 gene, which codes for a homeobox transcription factor, was identified in this region through sites of duplicating and transmutation screening in ARS families. [6] Since its discovery, about 30 transformations have been originate in the PITX2 gene, mostly involving point mutations within the homeodomain, resulting in haploinsufficiency. Chromosomal breakpoints on 4q have also been observed in DNA from families affected by ARS. Only one ARS patient has been documented with a minor obliteration in the PAX6 gene on 11p13, marking the sole reported case of complete ARS syndrome involving ocular, dental, and umbilical features linked to a PAX6 transmutation so far. Other studies have associated PAX6 transmutations with Axenfeld anomaly (AA) and iris hypoplasia (IH) phenotypes. In addition, some ARS patients exhibit stable chromosomal translocations affecting different genomic regions, hinting at the possible involvement of additional genetic loci in this disorder. Researchers have identified chromosome malformations on 4, 13, and 6 in ARS patients to pinpoint gene-containing regions linked to the disorder. Chromosome 16q has also been associated with ARS, with the transcription factor MAF identified as a prominent candidate gene in this region. Additionally, locus 13q14 has been linked to deletions observed in two cases within a large family through linkage analysis. However, this family also exhibited non-ARS syndromic issues such as hip, kidney, and hearing problems, alongside typical ARS features like glaucoma and dental abnormalities. As of now, no specific gene-carrying transmutations or reorganizations in this chromosomal region have been identified in DNA from these individuals [7, 8].

Variants of PITX2 and their Biochemical Properties

The PITX gene family—PITX1, PITX2, and PITX3—shows overlapping expression throughout developing growth and portions of substantial correspondence in protein and

nucleotide sequences. In mice, Pitx1 is mainly involved in pituitary and hind leg development, while its human counterpart's specific role remains unclear. PITX3 is crucial for the development of the eye and brain and is linked to aphakia in mice and anterior part dysgenesis in individuals. [9,10].

Models Using Animals and Cell Cultures

PITX2 protein and mRNA are mainly localized to the leftward adjacent during initial organ development in vertebrates, including the heart, lungs, and gut. PITX2 functions down level of Nodal and Lefty2 in the Nodal–Sonic-hedgehog pathway, which governs leftward–rightward asymmetry. Interestingly, ARS patients do not exhibit asymmetry defects. Many humanoid PITX2 mutations encompass point changes within the analysis edge, particularly affecting the homeodomain. These mutations often disrupt DNA-binding or transactivation abilities in cell culture experiments. [11] One specific change causing ARS, K88E in PITX2, demonstrates dominant-negative behavior in biochemical and transfection studies. In this scenario, the heterodimeric PITX2 protein formed by unique wild-type and one mutated form fails to effectively interact with co-factors like PIT1, crucial for complete activation of mark genes such as prolactin. Conversely, experiments with the T68P mutation, also linked to ARS, do not interfere with transactivation when co-expressed with wild-type PITX2. Interestingly, this contradicts clinical observations where individuals carrying the heterozygous T68P mutation show severe full-spectrum ARS, despite the T68P–wild-type heterodimer functioning normally in cell culture models. [12, 13]

Regulatory Pathways that Control Genes both Upstream and Downstream of PITX2

The PITX2 homeobox transcript feature is fragment of a complex gene regulatory structure that is not fully understood. Different tissues, developmental stages, and model organisms likely involve multiple alternative networks. Among the paths upregulation of Pitx2, the Nodal–Sonic hedgehog (Shh) pathway is extensively studied but not exclusive. It is crucial for establishing left–right split in mesoderm derivative organs such as the heart, gut, and lungs. [14] This pathway integrates Shh signaling via Patched and Nodal signaling through activin receptors, which are connected to Smad intracellular pathways. This results in specific upregulation or conservation of Pitx2 gene appearance on the left side of certain tissues, with varying left-specific isoforms observed across different models. The upstream interactors that directly influence Pitx2 in this pathway have not yet been identified. [15]

Moreover, an alternative non-asymmetric pathway suggests that Pitx2 operates downregulation of the Wnt–Frizzled–β-catenin pathway during heart and pituitary development. The relationship between Wnt and Shh pathways in variable Pitx2 is not yet fully understood. More than a few genes down level of Pitx2 directive have been identified through biochemical and genetic research. For example, in the pituitary gland, Pitx2 and Pit1 cooperate to enhance prolactin gene transcription. In the heart, Pitx2, with its co-factor Nkx2.5, upregulates atrial natriuretic factor gene transcription, influenced by Nkx2.5 binding sites in the Pitx2 gene, contributing to left–right asymmetric expression. Research gaps persist in understanding the full scope of upstream signals regulating Pitx2 and its diverse downstream targets in various tissues. Numerous additional pathways likely regulate Pitx2 in different cellular contexts, with several more downstream targets implicated in diseases like Axenfeld-Rieger syndrome (ARS). [16,17] DLX2, affecting tooth abnormalities, and PLOD2, influencing ocular phenotypes, are relevant ARS-related downstream targets. Mutations in PITX2 affecting these targets correlate with observed effects in DLX2 reporter genetic factors in cell culture. A high level of PITX2A in corneas mildly downregulates PLOD2, leading to corneal clouding, collagen defects, and severe optic nerve degeneration (glaucoma) with associated retinal damage. Investigating gene regulatory pathways specific to different cell types and developmental stages is critical for understanding the roles of transcription factors such as Pitx2. Recent findings indicate that crucial eye tissues in these illnesses grow from neural crest and mesoderm origins, both involving Pitx2 activity. [18]

Conclusion:

ARS presents serious clinical consequences, including conditions like glaucoma and omphalocele. However, due to its rarity, widespread prenatal screening for ARS is challenging. Prenatal genetic diagnosis is feasible only in families where mutations or deletions in PITX2, FOXC1, or PAX6 are identified. Regular glaucoma screenings are crucial throughout the lives of affected individuals, as about half of ARS patients develop this condition in one or both eyes. ARS serves as a valuable model for studying genetic disorders involving transcription factors during development. Two main regulatory ways up levels of Pitx2 have been identified: The Wnt–β-catenin–Pitx2–CyclinD2 pathway and the Nodal–Shh–Lefty2–Pitx2 pathway. Numerous down level aim genetic factor of Pitx2 have remained recognized across various purposeful categories, including transcript issues, cell cycle regulators, growth factors, morphogens, and enzymes adjusting the

extracellular matrix. It remains unclear if these pathways interact or if additional pathways regulate Pitx2. The relationship between these target genes and the identified pathways is still uncertain, and more Pitx2 target genes will likely be discovered. Recent research advancements, such as the identification of gain-of-function mutations in humans and studies on PITX2 high level of appearance in mice, suggest the option of verdict additional high-of-work regulations transmutations in human patients. Understanding the identity and roles of extra down level of target genes is expected to differ depending on tissue thoughtful and growing stage, potentially requiring tissue- and stage-specific cofactors for Pitx2 function.

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PERSONALIZED MEDICINE: HARNESSING GENOMICS FOR BETTER PRESCRIPTIONS

Cyril Sajan*, Varunsingh Saggu, Dilsar Gohil,
Rajesh Hadia and Hemrajsingh Rajput
Department of Pharmacy,
Sumandeep Vidyapeeth Deemed to be University,
Piparia, Vadodara, Gujarat, Pin Code :391760
*Corresponding author E-mail: cyrilsajan97@gmail.com

Abstract:

Advancements in genomics are transforming the process of tailoring prescriptions to individual patients, ushering in a new era of personalized medicine. This chapter delves into the integration of genetic profiling into clinical practice, allowing healthcare providers to customize drug therapies based on each patient's genetic characteristics. It explores the scientific underpinnings of pharmacogenomics, where genetic differences impact how drugs are metabolized, their effectiveness, and safety profiles. Through case studies, the chapter illustrates successful instances of personalized treatments, resulting in improved patient outcomes and fewer adverse effects. Additionally, it addresses the ethical, legal, and societal considerations associated with genomic medicine, such as privacy issues and the necessity for regulatory frameworks. By examining current trends and future prospects, this chapter offers a comprehensive overview of how genomics is reshaping the landscape of personalized prescriptions.

Keywords: Individualized Healthcare, Genome Science, Pharmacogenetic Analysis, Genetic Characterization, Customized Medication Regimens, Medication Metabolism, Genetic Medication Response, Genetic Diversity

Introduction:

Personalized healthcare marks a significant shift in the medical field, moving beyond conventional, generalized treatments towards more precise, individualized care based on a patient's distinct genetic composition. This transformation is propelled by advancements in genomics, the study of an organism's entire DNA sequence, encompassing all its genes. These advancements have deepened our understanding of how genetic factors influence health and disease, paving the way for more targeted and efficient treatments. The role of genomics in personalized medicine is particularly evident in pharmacogenomics, which

investigates how genetic variations impact an individual's response to medications. By analyzing a patient's genetic makeup, healthcare providers can tailor drug therapies to enhance effectiveness and minimize adverse reactions. This personalized approach not only improves patient outcomes but also reduces the trial-and-error process commonly associated with medication prescriptions.

This chapter delves into the scientific underpinnings of genomics and its application in tailoring prescriptions to individual patients. We will explore how genetic profiling is integrated into clinical practice to inform treatment decisions, with a focus on key medical areas such as oncology, cardiovascular disease, and psychiatry. Additionally, we will address the ethical, legal, and social considerations of genomic medicine, including concerns regarding privacy, informed consent, and equitable access to genetic testing and treatment. Lastly, we will examine future prospects in personalized medicine, including the potential of multi-omics approaches and artificial intelligence to further refine and improve personalized healthcare delivery. As we explore the role of genomics in personalized medicine, it becomes evident that this approach holds tremendous potential to revolutionize healthcare by offering treatments tailored to the unique genetic profiles of individual patients. This not only enhances the quality of care but also empowers both patients and healthcare providers with the knowledge needed to make informed and effective treatment decisions.

The Science of Genomics in Medicine

Genomics, which examines an organism's entire DNA complement, encompassing all of its genes, has significantly transformed our comprehension of biology and medicine. In personalized medicine, genomics furnishes the fundamental knowledge needed to customize medical treatments according to individual patients' genetic profiles. This segment delves into the scientific principles of genomics and its practical applications in medicine, with a particular emphasis on pharmacogenomics—a field that investigates how genetic disparities impact drug responses.

Essential Concepts of Genomics

Genomics encompasses several key concepts that are essential for understanding its application in personalized medicine:

- Genome: The entirety of an organism's DNA, encompassing all its genetic material. The human genome consists of approximately 3 billion base pairs and roughly 20,000-25,000 genes.
- Gene: A DNA segment containing instructions for synthesizing specific proteins or protein sets.
- Genetic Variation: Discrepancies in DNA sequences among individuals, which can influence gene functionality and individual responses to diseases and treatments.

Types of Genetic Variations

- **Single Nucleotide Polymorphisms (SNPs)**: The most frequent genetic variation, involving a single base pair alteration in the DNA sequence. SNPs may impact individuals' drug metabolism and susceptibility to adverse drug reactions.
- **Insertions and Deletions (Indels)**: Additions or deletions of small DNA segments, which can affect gene function and protein production.
- **Copy Number Variations (CNVs)**: Disparities in the number of copies of a particular gene, potentially leading to alterations in gene dosage and influencing drug responses.

Pharmacogenomics: The Intersection of Genomics and Drug Response Pharmacogenomics investigates how genetic variations influence an individual's reaction to medications. Its objective is to enhance drug therapy by customizing treatments based on genetic profiles, thereby enhancing effectiveness and minimizing adverse effects.

Drug Metabolism and Genetic Variation

The process of drug metabolism involves a sequence of biochemical reactions that transform medications into either active or inactive forms. Essential enzymes, predominantly found in the liver, facilitate these reactions. Genetic variances can profoundly affect the function of these enzymes, thus influencing the rates and outcomes of drug metabolism.

Cytochrome P450 Enzymes (CYPs), a group of enzymes responsible for metabolizing numerous drugs, exemplify this phenomenon. Variations in CYP genes, such as CYP2D6, CYP2C9, and CYP2C19, can result in distinct metabolizer phenotypes:

- Poor Metabolizers: Individuals exhibiting markedly reduced or absent enzyme activity. They may necessitate lower drug doses to prevent toxicity.
- Intermediate Metabolizers: Individuals displaying diminished enzyme activity, possibly requiring dosage adjustments.

- Extensive Metabolizers: Individuals with typical enzyme activity, whereby standard drug doses are generally efficacious.
- Ultra-Rapid Metabolizers: Individuals demonstrating heightened enzyme activity, potentially necessitating higher drug doses to attain therapeutic effects.

For instance, the CYP2D6 enzyme is involved in metabolizing drugs like codeine, antidepressants, and antipsychotics. Genetic variations in the CYP2D6 gene can yield contrasting responses to these medications. Poor metabolizers may encounter adverse effects at standard doses, whereas ultra-rapid metabolizers may require elevated doses to achieve the desired therapeutic outcome.

Antibiotic Stewardship and Prescription Practices

Antibiotic stewardship is a critical component of responsible antibiotic use aimed at optimizing patient outcomes, minimizing adverse effects, and combating the global threat of antibiotic resistance. In this section, we explore the principles of antibiotic stewardship and their implications for prescription practices in healthcare settings.

Principles of Antibiotic Stewardship

Antibiotic stewardship plays a crucial role in promoting responsible antibiotic usage with the aim of enhancing patient outcomes, minimizing adverse effects, and addressing the global threat posed by antibiotic resistance. This section delves into the principles of antibiotic stewardship and their implications for prescribing practices in healthcare settings.

Principles of Antibiotic Stewardship:

1. Adherence to Guidelines: Consistently following evidence-based guidelines concerning antibiotic selection, dosage, and treatment duration.
2. Diagnostic Guidance: Employing appropriate diagnostic tests to confirm bacterial infections and guide antibiotic treatment decisions, thereby avoiding unnecessary antibiotic use for viral infections.
3. De-escalation and Rationalization: Regularly reassessing antibiotic therapy and adjusting treatment based on clinical response and microbiological findings to optimize efficacy and minimize adverse effects.
4. Duration Optimization: Prescribing the shortest effective duration of antibiotic therapy to mitigate the risk of antibiotic-related adverse effects and the development of resistance.

5. Infection Control Measures: Implementing measures to prevent the transmission of resistant bacteria within healthcare facilities and the community through infection prevention and control protocols.
6. Education and Training: Offering education and training programs to healthcare professionals, patients, and caregivers on appropriate antibiotic usage, antimicrobial resistance, and the significance of antibiotic stewardship in safeguarding public health.

Antibiotic Prescription Practices

Integrating antibiotic stewardship principles into prescribing practices involves several key aspects:

1. **Diagnostic Evaluation:** Utilize diagnostic tools, such as bacterial cultures and susceptibility tests, to confirm bacterial infections and inform antibiotic choice. Rapid point-of-care tests can offer quick results, supporting timely treatment decisions.
2. **Empirical Treatment:** Administer antibiotics based on clinical judgment and local epidemiological data while awaiting test results. This treatment should follow evidence-based guidelines and be tailored to individual patient factors, including age, health status, and potential resistance risks.
3. **Preference for Narrow-Spectrum Antibiotics:** Whenever possible, select narrow-spectrum antibiotics over broad-spectrum ones to specifically target the pathogen and reduce the impact on the microbiota, thereby decreasing the likelihood of resistance development.
4. **Optimal Dosage Management:** Ensure proper antibiotic dosing by taking into account factors such as kidney function, body weight, and age to achieve therapeutic levels while minimizing toxicity and the risk of resistance.
5. **Regular Review of Treatment Duration:** Continually assess the necessity for continued antibiotic therapy and stop treatment when appropriate, instead of strictly following pre-set durations.
6. **Patient Education and Engagement:** Involve patients in decision-making and educate them on the importance of completing antibiotic courses, adhering to preventive measures, and recognizing signs of treatment failure or adverse effects.
7. **Implementation of Monitoring and Feedback Systems:** Set up systems to track antibiotic prescribing patterns, monitor antimicrobial resistance, and evaluate

patient outcomes, providing feedback to healthcare providers to promote ongoing improvement in antibiotic stewardship.

Applications of Genomics in Personalized Medicine

The field of genomics, which explores the complete DNA structure of organisms, has revolutionized personalized medicine by uncovering individual genetic variations that influence health and disease. These insights enable healthcare providers to tailor medical treatments to each patient's unique genetic profile, thereby improving efficacy and minimizing side effects. In this section, we examine the diverse applications of genomics in personalized medicine across different medical fields.

Oncology

In the field of oncology, genomics plays a crucial role in informing treatment decisions and enhancing patient outcomes. Tumor genetic analysis allows oncologists to pinpoint particular genetic mutations that propel cancer growth, aiding in the selection of targeted therapies. For instance:

- **Targeted Therapies**: Medications like imatinib and trastuzumab are designed to zero in on specific genetic abnormalities, such as BCR-ABL fusion genes in chronic myeloid leukemia and HER2 amplification in breast cancer, respectively.
- **Immunotherapy:** Genomic profiling can identify tumors exhibiting elevated levels of tumor mutation burden or specific immune-related biomarkers, assisting in the choice of immunotherapies like immune checkpoint inhibitors.

Genomic insights also aid in forecasting prognosis and monitoring treatment response, facilitating personalized treatment approaches for cancer patients.

Cardiovascular Disease

Genomics holds significance in assessing, preventing, and treating cardiovascular diseases. Genetic analysis enables the identification of individuals with heightened susceptibility to cardiovascular conditions, enabling early interventions and personalized preventive measures. Additionally:

Pharmacogenomics: Genetic variances influence how individuals respond to cardiovascular medications like antiplatelet agents and statins. Screening for pertinent genetic markers assists in optimizing drug selection, dosages, and monitoring. Inherited Cardiomyopathies and Arrhythmias: Genomic testing aids in diagnosing inherited cardiomyopathies and arrhythmias, guiding family screening and management approaches. Through the integration of genomics into cardiovascular care, healthcare providers can

more effectively tailor interventions to meet individual patient needs, thereby enhancing outcomes and alleviating the burden of cardiovascular disease.

Pharmacogenomics

Pharmacogenomics explores the impact of genetic variations on individual responses to medications, aiding in the development of personalized prescribing practices. Key applications of pharmacogenomics include:

- **Medication Selection and Dosage:** Genetic testing helps identify patients who may not respond well to certain drugs or are at an increased risk for adverse reactions. This information guides the choice of medication and dosage adjustments to enhance treatment effectiveness.
- **Antidepressants and Antipsychotics:** Genetic testing can be instrumental in choosing and dosing antidepressants and antipsychotic medications, thereby reducing the risk of ineffective treatment or adverse effects.
- **Antiplatelet Therapy:** Variations in genes like CYP2C19 can affect how patients respond to antiplatelet drugs such as clopidogrel. Pharmacogenomic testing helps identify individuals who might benefit from alternative therapies or dosage adjustments.

Integrating pharmacogenomic insights into clinical practice enhances medication efficacy, safety, and patient satisfaction.

Infectious Diseases

Genomics has significantly advanced the diagnosis, treatment, and prevention of infectious diseases. Modern sequencing technologies allow for rapid and detailed pathogen analysis, facilitating:

- **Antimicrobial Resistance Monitoring:** Genomic data is used to track the spread of antimicrobial resistance genes and detect emerging resistance trends, supporting effective antimicrobial stewardship.
- **Outbreak Investigation:** Genomic epidemiology helps trace the transmission pathways during outbreaks, such as those seen with COVID-19, enabling targeted interventions and control measures.
- **Precision Antimicrobial Therapy:** Pathogen genome profiling helps select specific antimicrobial treatments, improving treatment success rates and reducing the risk of treatment failure or adverse reactions.

Leveraging genomic information allows healthcare providers to adopt personalized approaches to managing infectious diseases, thereby helping to alleviate their global impact.

Rare Diseases

Genomics has transformed the approach to diagnosing and managing rare genetic diseases. Advances in sequencing technologies have enabled:

- **Genetic Diagnosis:** Whole-exome and whole-genome sequencing identify disease-causing genetic mutations in patients with undiagnosed or rare conditions, leading to individualized treatment strategies.
- **Precision Therapies:** Tailored therapies that address the specific genetic causes of rare diseases offer new treatment options for patients with particular genetic variants.
- **Family Screening and Counseling:** Genetic testing helps identify family members at risk, allowing for genetic counseling, family planning, and cascade screening to prevent the transmission of genetic diseases.

By utilizing genomics, clinicians can provide accurate and timely diagnoses, personalized treatment plans, and informed guidance to patients and their families affected by rare genetic disorders.

Ethical, Legal, and Social Implications

While genomics offers significant potential for advancing personalized medicine, its broad application introduces critical ethical, legal, and social challenges that need thorough examination. This section delves into the key issues related to incorporating genomics into healthcare.

Privacy and Confidentiality

Genetic data is highly sensitive, revealing detailed information about a person's health, ancestry, and familial ties. Protecting the privacy and confidentiality of this information is crucial to prevent potential harm, discrimination, or stigmatization of patients. However, maintaining strong data security and preventing unauthorized access or misuse is a significant challenge. It is essential to balance the need for data accessibility for healthcare purposes with the protection of patient privacy to sustain trust and confidence in genomic medicine.

Informed Consent

Securing informed consent for genetic testing and genomic analysis is crucial for respecting patient autonomy and ensuring transparency in healthcare decisions. Patients need to be fully informed about the purpose, risks, benefits, and limitations of genetic testing, as well as the usage, storage, and sharing of their genomic data. However, the complexity of genomic information and the potential impact of genetic findings can make it difficult to achieve genuinely informed consent. Enhancing patient education, communication, and understanding is essential to empower individuals to make well-informed decisions regarding genetic testing and involvement in genomic research.

Equity and Access

The potential of personalized medicine depends on ensuring equitable access to genomic technologies and healthcare services for all individuals. Unfortunately, disparities in access to genetic testing and genomics-based treatments are prevalent, disproportionately affecting marginalized and underserved communities. Factors such as socioeconomic status, geographic location, and uneven healthcare infrastructure contribute to these inequities. To address these issues, it is crucial to improve healthcare accessibility, increase affordability, and provide culturally sensitive care. Furthermore, it is essential to take steps to prevent genomic technologies from worsening existing health disparities, thus promoting health equity and social justice.

Genetic Discrimination

Concerns about genetic discrimination, which refers to the unfair treatment of individuals based on their genetic information, are significant in the context of genomic medicine. The fear that employers, insurers, or other entities may discriminate based on genetic data can discourage people from undergoing genetic testing or sharing their genomic information. Legislation like the Genetic Information Nondiscrimination Act (GINA) in the United States provides some protections against genetic discrimination in employment and health insurance. However, existing gaps in legal protections and enforcement mechanisms leave individuals vulnerable to potential misuse of their genetic data. Ongoing advocacy for stronger legal safeguards and increased public awareness is essential to prevent genetic discrimination and ensure equity and justice in the field of genomic medicine.

Psychological and Social Impact

The impact of genomic testing goes beyond physical health, affecting psychological and social aspects as well. Test results may disclose unexpected or potentially distressing information regarding disease risks, carrier status, or family relationships, which can lead to anxiety, uncertainty, or emotional distress. Offering thorough pre- and post-test counseling, along with access to supportive resources and mental health services, is crucial to help individuals and families manage the psychosocial effects of genomic testing. Furthermore, enhancing public education and normalizing conversations about genetics and genetic conditions can promote greater understanding, acceptance, and empowerment within communities.

Conclusion:

As genomics progresses and becomes more ingrained in clinical settings, it's crucial to acknowledge and tackle the ethical, legal, and social concerns linked to its application. By upholding principles like autonomy, justice, beneficence, and nonmaleficence, healthcare stakeholders can navigate the intricate ethical landscape of genomic medicine in a responsible and ethical manner. Collaborative endeavors involving policymakers, healthcare providers, researchers, patients, and communities are vital to ensure that genomic technologies are utilized for the well-being of everyone, while maintaining core ethical values, equity, and justice in healthcare.

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About Editors

Dr. R. S. Tayde is a distinguished academician with over 12 years of experience in teaching, research, and extension. He holds a Bachelor's degree in Veterinary Science and Animal Husbandry from MAFSU, Nagpur (M.S.), a Master's in Veterinary Public Health from AAU, Anand, (GJ) and a Ph.D. from prestigious ICAR-IVRI, Bareilly, (U.P.). He also earned a PG Diploma in One Health from KVASU, Pookode (KL), and is ICAR-NET and UGC-NET qualified with JRF. Currently, Dr. Tayde serves as an Assistant Professor cum Scientist at the Department of Veterinary Public Health & Epidemiology, College of Veterinary Science & Animal Husbandry, Mhow, Indore, (M.P.). His expertise focuses on AMR, food safety, zoonoses, and epidemiology, with several scientific publications to his credit.

Dr. Ankita Sharma has completed MSc Honours in Foods and Nutrition in 2000 and Ph.D. in year 2005 by Foods and Nutrition discipline ICMR Fellowship from MPUAT, Udaipur. She is awarded as M Sc (Microbiology) by KSOU Mysore. She qualified UGC and ICAR NET for lectureship. She has more than 15 years Research, Teaching, Nutrition Counseling and Extension services experience. She has served as Consultant IYCF for UNICEF Jaipur. During this tenure she has edited the State Guidelines of Infant and Young Child Feeding for State Rajasthan and Guidelines for Front Line Workers under IDCF Campaign of Dept of Health and Family Welfare Raj. She is the members of more than 15 professional educational societies and attended more than 25 conferences, workshops and seminars. She has published more than 50 Research papers and popular articles. She has developed low Glycemic composite flour as per staples of Rajasthan, low Glycemic papaya based food preparations and corn instant mix for Jhajharia. She is selected for Achiever Award 2019, Indira Mahila Shakti Puraskar2021&23 by Deptt. of woman and child and Deptt. of Rural Development and Panchayati Raj. Sirohi, Award of excellence in research, Young Woman Scientist and Excellence in Public Health &Nutrition by IAPEN Pune MH. She is currently working as KVK Scientist and Subject Matter Specialist in ICAR-Farm Science Centre Sirohi, Agriculture University Jodhpur. She is a well versed researcher and extension Scientist working at Sirohi, Raj.

Dr. Shafia Jan, M.Sc. M.Phil., Ph.D. is a progressive academician with 20+ years of teaching and research experience in various blends of Home Science including Food & Nutrition, Dietetics and clinical Nutrition. Her main area of research is in community nutrition and is actively involved in Community Connect Programs in terms of teaching and field practice. She is a gold medallist throughout her academic career and has presented a good number of research papers at national and international conferences. She has also published many books, chapters and articles in international journals.

Mr. Sonam Bhutia is an Assistant Professor, SWAYAM Co-coordinator, and NCC Caretaker Officer at Government Pharmacy College Sajong, affiliated with Sikkim University, Rumtek-Sajong, Gangtok, Sikkim. With over nine years of teaching and research experience in the pharmaceutical field, he is the first person from Sikkim to receive the prestigious SPER Young Teacher Award in 2023. He holds one published patent and one granted patent, and has authored nine research/review papers in Scopus and ESCI Indexed journals. Additionally, he has written three books and five book chapters. Mr. Bhutia is a lifetime member of several educational and scientific communities, including APTI, The American Society of Pharmacognosy, and SPER. He serves on the editorial boards of the International Journal of Pharma Investigations and the International Journal of Pharma & Chemistry and reviews for over 30 UGC Care listed journals. He also holds various roles at his college, including SWAYAM Coordinator and Examining Authority for the Diploma in Pharmacy program. Passionate about research, he aspires to become a Doctor of Pharmacy.

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