



Review Article

Review on Green Pharmacy Practice

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ABSTRACT

Green Pharmacy integrates ecological sustainability into pharmaceutical sciences, emphasizing the minimization of environmental impact throughout a drug's life cycle from design and production to consumption and disposal. It advocates plant-based healing, responsible waste management and the rational use of medicines. This discipline connects environmental ethics with pharmaceutical practice by addressing issues such as drug pollution, resource depletion and carbon emissions associated with medicine manufacture. Sustainable pharmacy further expands the concept by incorporating educational, social, and economic dimensions into healthcare. This review explores the evolution of green pharmacy, its guiding principles and the major approaches adopted in modern pharmaceutical systems. The paper examines global and national initiatives aimed at promoting environmental responsibility, highlights current trends such as green prescriptions and eco-friendly manufacturing, and discusses future prospects including artificial intelligence, biodegradable drug delivery systems and sustainable sourcing.

INTRODUCTION

Green pharmacy and Sustainable pharmacy:

Green pharmacy: Green pharmacy is the integration of primarily ecological aspects into the pharmaceutical sciences. It focuses on pharmaceuticals and their residues throughout their lifecycle at the resource level and introduces measures to change processes with the aim of

making products and processes more environmentally friendly or “green (er)”.

Sustainable pharmacy: Sustainable pharmacy is the simultaneous, equal and dynamic integration of educational, environmental, societal, economic, pharmacological and cultural aspects into the pharmaceutical sciences^[1]. Green pharmacy is the development of new substances that are more efficiently biodegraded but retain their effective pharmaceutical properties^[2]. The concept of green

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pharmacy has origins in ancient medical systems like Ayurveda and Traditional Chinese Medicine, which promoted harmony with nature and sustainable use of resources. With the rise of synthetic medicines during the industrial revolution, pollution and pharmaceutical residues in the environment became major concerns. By the late 20th century, the detection of drugs in water sources prompted global action^[3]. Organizations such as WHO and FIP emphasized environmental responsibility, and in 2015 FIP released guidelines for sustainable pharmacy practice. Today, green pharmacy blends traditional wisdom with modern science, aiming to provide effective therapy while protecting the environment and promoting community awareness^[4].

Advantages

1. Reduced Pollution: Green synthesis and biodegradable APIs prevent the accumulation of pharmaceutical residues in soil and water.
2. Safer Medicines: Plant-based and eco-designed drugs generally exhibit fewer side effects.
3. Public Health Protection: Proper waste disposal prevents accidental ingestion or contamination.
4. Cost Savings: Energy efficiency and reduced wastage lower operational costs.
5. Green pharmacy initiatives play a vital role in safeguarding the environment and public health by addressing the contamination of ecosystems with pharmaceutical contaminants particularly APIs that how they are harming the aquatic life and the ecosystem^[5].

Disadvantages

1. Lack of Standardization
2. Knowledge and Awareness Gaps
3. Economic and Infrastructural Constraints
4. Research and Data Limitations^[6].

Principles of Green Pharmacy Practice

1. **Sustainability:** The Green Pharmacy underscores the significance of sustainability by advocating for the responsible and ethical use of natural resources. It promotes practices that ensure these resources are conserved and utilized in a way that allows them to remain accessible and viable for future generations.
2. **Plant based Healing:** The fundamental concept of Green Pharmacy revolves around utilizing plants and herbs to support healing and enhance well-being. These natural treatments are considered to be mild on the body and are associated with fewer side effects in comparison to conventional pharmaceutical drugs.
3. **Holistic Approach:** Green Pharmacy embraces a holistic perspective that acknowledges the deep connection between the mind, body and environment. It promotes a comprehensive approach to health that considers not only physical conditions but also the mental and emotional aspects of well-being, supporting overall harmony and balance.
4. **Reduced environmental impact:** Green Pharmacy plays a vital role in promoting a healthier environment by lessening dependence on synthetic drugs and chemical treatments. This principle supports environmentally sustainable healthcare practices that reduce the ecological footprint of medicine use.
5. **Prevention and wellness:** Green Pharmacy emphasizes a preventive approach rather than just addressing symptoms. It encourages adopting a lifestyle that fosters overall well-being through balanced nutrition, regular

physical activity and mindfulness practices to sustain good health.

6. Individualized medicine: Green Pharmacy acknowledges that every person has distinct healthcare requirements. It supports a tailored treatment approach where therapies are customized to meet the unique conditions and needs of the individual, ensuring more precise and effective care^[7].

Importance of Green Pharmacy Practice

1. Green pharmacy encompasses the full life cycle of medications, including eco-friendly design and development, responsible prescribing, dispensing and safe disposal.
2. It promotes environmental awareness among pharmacists and patients, encouraging the selection of medicines with reduced environmental impact and participation in proper drug disposal programs.

3. Improper disposal of medicines can contaminate water and soil, harming ecosystems and human health; green pharmacy advocates safe disposal of expired or unused drugs and emphasizes pharmacists' role in educating patients and supporting take-back initiatives.
4. Sustainable healthcare also takes into account social and economic factors, such as promoting generic drugs and reducing medication waste to lower healthcare costs and improve accessibility, with pharmacists playing a crucial role in patient education and sustainable medication use.
5. Energy consumption in pharmacies, especially in hospitals, is significant; adopting energy-efficient technologies, including energy-saving refrigerators and green building standards, can greatly reduce the carbon footprint of pharmaceutical services^[8].

Approaches of Green Pharmacy Practice

Table No. 1 Approaches of Green Pharmacy Practice [9]

Approaches	Primary Objective	Environmental Impact
HANDLING OF GOODS AND STOCKS (Inventory Management)	Reduce expired waste	Lowers landfill contamination
TRANSPORTATION (Sustainable Transport)	Reduce carbon emissions	Supports low-carbon logistics
WASTE MANAGEMENT	Safe medicine disposal	Reduces chemical emissions
MANUFACTURING OF OWN BRAND PRODUCTS -Green Manufacturing -Green Packaging	Eco-friendly production Minimize plastic	Enhances recyclability
OTHER AREAS -Energy-Efficient Infrastructure -Education & Awareness	Save energy and resources Inform public and professionals	Reduces carbon footprint Promotes responsible behavior

Green Prescription Trends

Green prescription trends refer to the increasing recognition by healthcare professionals of the

potential health benefits of outdoor and nature-based activities and their incorporation into patient treatment plans.



1. Nature Prescriptions:

- Healthcare providers are increasingly "prescribing" time spent in natural environments or engagement in outdoor activities as part of a patient's treatment plan.
- Nature prescriptions may include activities like hiking, gardening, bird-watching or simply spending time in a natural setting.

2. Mental Health Benefits:

- There is growing awareness of the positive impact of nature on mental health. Exposure to green spaces has been associated with reduced stress, anxiety and depression.
- Green prescriptions may be recommended for individuals dealing with mental health conditions.

3. Physical Health:

- Spending time in nature and engaging in outdoor activities can have physical health benefits as well.

- For example, it can promote physical fitness, reduce the risk of chronic diseases and improve overall well-being [3].

Key Opportunities for Indian Pharma Companies To Drive Sustainability

- Power purchase agreements & enhanced usage of renewable energy.
- Establishing partnerships within pharma, onboarding green suppliers and elevating green transportation.
- Enhanced focus around Zero waste strategy & responsible water usage across complete value chain.
- Making R&D activities sustainable by utilizing principles of "Sustainability by Design".
- Use of automation and digitalization across the value chain to reduce environmental footprints [10].

Future Trends for Green Pharmacy

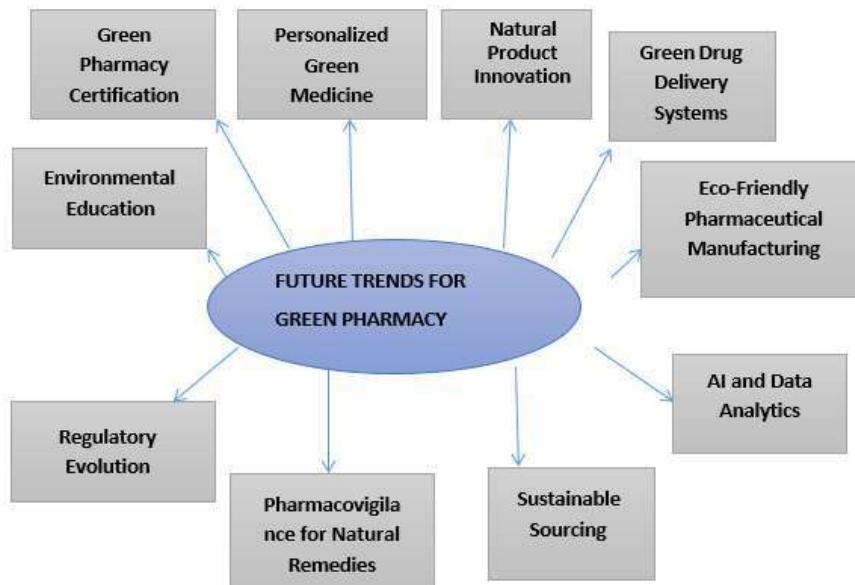


Fig. No. 1 Future Trends For Green Pharmacy

➤ Personalized Green Medicine:

The advancement of precision medicine and modern technologies has the potential to create

personalized green medicine. This approach tailors treatments based on an individual's genetic profile, lifestyle, and environmental influences to reduce side effects and enhance the effectiveness of natural remedies.

➤ **Natural Product Innovation:**

Ongoing research on plant-based compounds and natural substances is expected to discover new, effective therapeutic options. This includes identifying novel bioactive molecules from plants and developing innovative herbal formulations for better health outcomes.

➤ **Green Drug Delivery Systems:**

The focus is on developing eco-friendly drug delivery methods using biodegradable carriers and sustainable packaging to reduce waste and environmental harm.

➤ **Eco-Friendly Manufacturing:**

Pharmaceutical

The industry is increasingly adopting green manufacturing practices aimed at lowering energy usage, waste production, and emissions during drug manufacture.

➤ **AI and Data Analytics:**

Advanced technologies like AI and data analytics will be utilized to enhance the development and application of green pharmaceuticals by predicting drug efficacy and environmental effects.

➤ **Sustainable Sourcing:**

There is a growing emphasis on ethically and sustainably sourcing natural ingredients, including protecting biodiversity and harvesting plants responsibly.

➤ **Green Pharmacy Certification:**

Certification programs may become more prevalent to ensure pharmacies follow sustainable operations, such as energy-efficient infrastructure and eco-friendly waste management.

➤ **Environmental Education:**

Healthcare providers and patients will receive more education about the health benefits of nature-based approaches and the importance of conservation within green pharmacy.

➤ **Regulatory Evolution:**

Authorities and government agencies may establish stricter rules and higher quality standards for environmentally sustainable pharmaceutical products. This could include formulating detailed regulations and guidance specifically for herbal medicines and eco-friendly drug formulations.

➤ **Pharmacovigilance for Natural Remedies:**

Enhanced systems for monitoring and reporting will be created to ensure the safety and effectiveness of natural or herbal remedies. These mechanisms will help maintain proper regulation, ensuring consistent quality and safety of such products^[3].

CONCLUSION

Green Pharmacy represents a vital and evolving approach within the pharmaceutical sector that harmonizes drug development and healthcare delivery with environmental sustainability. By focusing on eco-friendly practices throughout a medicine's lifecycle from sustainable sourcing and manufacturing to responsible prescribing and disposal it helps reduce pollution and safeguard ecosystems. Its emphasis on natural remedies and holistic care supports both patient wellness and environmental health. Government policies, awareness campaigns and technological



innovations are critical to advancing green pharmacy practices globally. Although challenges remain in standardizing herbal medicines and fully integrating sustainability into everyday pharmacy practices, ongoing research, education, and collaborative efforts promise a more sustainable pharmaceutical future. Ultimately, Green Pharmacy enhances public health while protecting the planet for current and future generations.

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