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Biochemical Insights from Medicinal Plants at the Interface of Human, Environmental, and Ecosystem Health

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Abstract

The One Health paradigm, recognizing the inextricable linkages between human, animal, plant, and environmental health, is critical for addressing complex global challenges like zoonotic pandemics, antimicrobial resistance, and pollution-driven diseases. Medicinal plants exist at the nexus of these interconnected systems. This narrative review synthesizes biochemical and pharmacological research on indigenous Nigerian flora through a One Health lens. We present evidence demonstrating how these plants function as multi-faceted health assets: (1) For Human Health, they provide protection against heavy metal hepatotoxicity (e.g., *Azanza garckeana vs*. manganese), management of chronic diseases (e.g., Vernoniaamygdalina in diabetes), and antimicrobial agents (e.g., *Chromolaena odorata*); (2) For Environmental Health, their metal-chelating and antioxidant properties suggest a potential role in phytoremediation strategies to mitigate soil and water contamination, while their use as green precursors for nanoparticles offers a sustainable alternative to chemical synthesis; (3) For Ecosystem & Knowledge Health, the scientific validation of these plants underscores the urgent need to conserve biodiversity and indigenous ethnobotanical knowledge as a vital, non-renewable health resource. This synthesis argues that investing in the biochemical study of medicinal plants is not merely a biomedical pursuit but a foundational One Health strategy. It calls for transdisciplinary research programs that simultaneously assess therapeutic efficacy, environmental application, and conservation status, thereby developing integrated solutions that promote resilience across all pillars of health in an increasingly stressed world.

Keywords: One Health; Medicinal Plants; Phytoremediation; Environmental Toxicology; Biodiversity Conservation; Indigenous Knowledge; Transdisciplinary Research.

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INTRODUCTION

Modern health crises from pandemics of zoonotic origin and the silent epidemic of antimicrobial resistance to the escalating disease burden linked to environmental degradation have made one truth undeniable: the health of humans, animals, plants, and ecosystems is deeply interconnected (One Health High-Level Expert Panel (OHHLEP) *et al.*, 2022; Destoumieux-Garzón*et al.*, 2018). The One Health approach has emerged as the essential framework for understanding and managing these complex interdependencies, advocating for integrated, cross-sectoral collaboration (Zinsstag *et al.*, 2011). At the heart of many of these challenges lies a common thread: the disruption of natural systems and the loss of biodiversity, which erodes the planet's innate capacity for regulation and healing.

Medicinal plants occupy a unique and pivotal space within the One Health matrix. They are simultaneously: a) a source of bioactive compounds for human and veterinary medicine; b) living organisms that interact with and can remediate their soil, water, and atmospheric environment; and c) vital components

of biodiversity whose loss constitutes an irreversible depletion of the global genetic pharmacy (Chen *et al.,* 2016; Yusuf *et al.,* 2023). The biochemical investigation of these plants, therefore, transcends traditional disciplinary boundaries. It can reveal molecules that heal human livers damaged by industrial pollutants, inform strategies for using plants to clean those pollutants from the environment, and provide a compelling economic and scientific rationale for conserving the species itself and the traditional knowledge surrounding it.

However, research on medicinal plants often remains compartmentalized. Pharmacologists study their therapeutic effects, environmental scientists their phytoremediation potential, and ethnobotanists their cultural significance. This siloed approach misses the synergistic power of a unified perspective. A biochemical finding in a rodent model of toxicity is not just a datum for a pharmacology journal; it is also a key piece of data for an environmental scientist exploring bioremediation options and for a conservation biologist arguing for habitat protection.

This narrative review adopts an explicit One Health framework to synthesize findings from our multi-year research program on the biochemistry of Nigerian medicinal plants. Our objective is to demonstrate how a single body of preclinical evidence can inform strategies across the health spectrum. We organize the synthesis into three core, interconnected domains:

1. ***Safeguarding Human Health:*** Reviewing evidence for the prevention and treatment of human diseases linked to environmental and infectious agents.
2. ***Mitigating Environmental Contamination:*** Exploring the potential of these plants, based on their biochemical properties, for environmental decontamination and sustainable nanotechnology.
3. ***Conserving Biodiversity and Indigenous Knowledge:*** Framing the scientific validation of these plants as a critical argument for conserving both biological and cultural diversity as indispensable health infrastructure.

By weaving these threads together, this review aims to illustrate that the biochemical study of medicinal plants is a prototypical One Health activity. It provides a template for how future research can be designed from the outset to generate knowledge that benefits human, environmental, and ecosystem health simultaneously, fostering true transdisciplinary innovation.

SAFEGUARDING HUMAN HEALTH

Human health is not an isolated condition but a dynamic state constantly influenced by the surrounding environment and microbial world. The rise of non-communicable diseases linked to pollution and lifestyle, coupled with the persistent threat of antimicrobial-resistant infections, exemplifies the breakdown of balance at the human-environment interface. Our research into medicinal plants provides robust evidence for their role in restoring this balance, offering biochemical tools to protect human health from these interconnected threats.

Counteracting Environmental Chemical Assaults: Industrial and agricultural activities have saturated environments with compounds foreign to human biology. Manganese (Mn), an essential trace element in excess, becomes a potent hepatotoxicant, primarily affecting workers in mining, welding, and battery manufacturing. Our investigation demonstrated that co-administration of *Azanza garckeana* fractions significantly attenuated Mn-induced liver damage in rats (Yusuf *et al.,* 2023). The plant extract restored the activity of key antioxidant enzymes (SOD, GPx) and reduced lipid peroxidation, indicating a direct neutralization of the oxidative stress cascade initiated by Mn accumulation. Similarly, *curcuminoids* from *Curcuma longa* provided pronounced protection against carbon tetrachloride (CCl_4)-induced hepatic injury, a model for solvent and halogenated hydrocarbon toxicity (Jonathan et al., 2020). These studies are not just about finding hepatoprotectants; they are about identifying biological countermeasures for human populations living or working in chemically burdened environments a core One Health concern where environmental contamination translates directly into human disease.

Addressing the Cross-Sectoral Crisis of Antimicrobial Resistance (AMR): AMR is a quintessential One Health challenge, with resistance genes flowing between humans, animals, and the environment. The urgent need for new antimicrobial scaffolds has turned attention back to plant chemistry. We found that phenolic and flavonoid-rich fractions from *Chromolaena odorata* and *Maytenus heterophylla* possessed significant antibacterial activity against pathogens like Staphylococcus aureus and Escherichia coli (Fagbohun *et al.,* 2025; Umar *et al.,* 2019). Moving beyond crude extracts, we employed a green chemistry approach, using *Senna occidentalis* leaf extract to synthesize silver and zinc oxide nanoparticles (Unuata *et al.,* 2025). These biosynthesized nanoparticles exhibited enhanced antimicrobial properties, likely due to a synergistic "phyto-corona" of plant metabolites coating the metal core. This work is directly relevant to a multi-pronged One Health strategy for AMR: it provides leads for new human and veterinary antimicrobials, and the green synthesis process itself reduces reliance on harsh chemical methods, aligning with principles of environmental health. Developing topical formulations from these sources could reduce the use of systemic antibiotics, thereby slowing resistance development.

Managing Metabolic Disorders in a Changing World: The global epidemic of type 2 diabetes and metabolic syndrome is deeply intertwined with nutritional transitions and environmental stressors. *Vernonia amygdalina* (bitter leaf), a common dietary vegetable, was evaluated in an alloxan-induced diabetic model (Ogar *et al.,* 2025). The extract demonstrated potent antihyperglycemic and antihyperlipidemic effects, while also protecting the liver and improving overall antioxidant status. This suggests that regular dietary intake can help modulate metabolic dysregulation. From a One Health perspective, promoting the cultivation and consumption of such functional local foods is a sustainable, preventive strategy that connects agricultural practice (plant health), dietary patterns (human health), and reduction in chronic disease burden (health system sustainability).

Chemoprevention: Intercepting Environment-Linked Carcinogenesis. Many cancers have environmental triggers, from dietary carcinogens to pollutants. Chemoprevention seeks to use natural or synthetic compounds to block these early stages. Our work on *Telfairia occidentalis* (fluted pumpkin) showed that its leaf extract could significantly inhibit the development of mammary tumors in a DMBA-induced breast cancer model (Adewuyi *et al.,* 2025). The mechanism involved the mitigation of carcinogen-induced oxidative stress and inflammation. This positions commonly consumed leafy greens as accessible, dietary chemopreventive agents. In public health terms, this bridges ecosystem health (maintaining diverse food crops) with human health (cancer prevention), encouraging agricultural and dietary choices that inherently reduce disease risk.

Synthesis for a One Health Perspective on Human Health: Collectively, this body of work (Yusuf *et al.,* 2023; Jonathan *et al.,* 2020; Fagbohun *et al.,* 2025; Umar *et al.,* 2019; Unuata*et al.,* 2025; Ogar*et al.,* 2025; Adewuyi *et al.,* 2025) illustrates that medicinal plants provide a versatile biochemical toolkit for protecting human health within a stressed planetary system. They offer:

- ***Biological Chelation & Detoxification:*** Against specific environmental toxicants like Mn and CCl_4.
- ***Novel Antimicrobial Arsenal:*** To combat infections in the era of AMR, sourced sustainably.
- ***Metabolic Regulators:*** To help manage diseases of nutritional and lifestyle transition.
- ***Dietary Chemopreventives:*** To lower cancer risk linked to environmental exposures.

The key insight is that these human health benefits are derived from plants that are themselves part of the ecosystem. Their use represents a strategy of working with natural systems to bolster human resilience, rather than relying solely on synthetic interventions that can sometimes exacerbate environmental problems (e.g., pharmaceutical pollution). This sets the stage for viewing these plants not just as human medicines, but as agents with roles that span the health of multiple domains.

PHYTOREMEDIATION AND GREEN NANOTECHNOLOGY POTENTIAL

This section transitions from how plants protect humans from the environment to how they can be used to heal the environment itself. The following studies were synthesized:

· The biochemical properties (metal chelation, antioxidant capacity) of plants like *A. garckeana* and *B. ferruginea* (Yusuf *et al.,* 2023; Adewuyi *et al.,* 2025) and discuss their phytoremediation potential.

· The green synthesis of nanoparticles (Unuata *et al.,* 2025; Unuata *et al.,* 2025) as an eco-friendly alternative to chemical synthesis, reducing industrial pollution.

· The concept of using plant biomass to clean contaminated sites (linking to the previous section's models of toxicity).

MITIGATING ENVIRONMENTAL CONTAMINATION

If the first pillar of One Health uses plants to protect humans from a damaged environment, the second pillar asks: can these same plants be deployed to repair the damage? Environmental contamination from heavy metals, agrochemicals, and industrial waste compromises ecosystem integrity, reduces agricultural productivity, and creates sustained exposure pathways that undermine human and animal health. Our biochemical research, while focused on therapeutic outcomes, reveals intrinsic plant properties that are directly relevant to environmental science, pointing toward sustainable strategies for remediation and cleaner industrial processes.

Biochemical Basis for Phytoremediation: Metal Chelation and Stress Tolerance. Phytoremediation is the use of plants to extract, stabilize, or degrade contaminants in soil and water. Its success hinges on a plant's ability to tolerate and process toxins. Our studies on plants used to counteract metal toxicity in animals provide indirect but powerful evidence of their phytoremediation potential. For instance, *Azanza garckeana's* efficacy in mitigating manganese-induced hepatotoxicity (Yusuf *et al.,* 2023) is rooted in its phytochemicals' ability to chelate or neutralize reactive Mn species and bolster antioxidant defenses. This suggests that *A. garckeana* may possess the physiological machinery to tolerate and perhaps accumulate Mn in its tissues, a key trait for phytoextraction. Similarly, the demonstrated protective effects of *B. ferruginea* extract against cadmium-induced multi-organ toxicity (Adewuyi *et al.,* 2025) imply a high degree of cadmium tolerance or sequestration capability within the plant. These preclinical findings should serve as a catalyst for direct environmental studies: cultivating these plants on metal-contaminated sites to measure their uptake capacity, translocation factors, and overall impact on soil health. By bridging therapeutic biochemistry and environmental botany, we can identify "dual-purpose" species that offer both a health product and an ecological service.

Green Nanotechnology: Reducing the Environmental Footprint of Synthesis. The environmental burden of nanotechnology often lies in its synthesis, which can involve toxic reducing agents and generate hazardous waste. Our work on the green synthesis of nanoparticles (NPs) using plant extracts presents a cleaner alternative that aligns with One Health principles. We successfully used extracts of *Senna occidentalis* to synthesize silver (Ag) and zinc oxide (ZnO) nanoparticles (Unuata *et al.,* 2025; Unuata *et al.,* 2025). In this process, phytochemicals like polyphenols and terpenoids act as non-toxic reducing and capping agents, determining the size, shape, and stability of the NPs. This method eliminates the need for many harsh chemicals, uses benign solvents (often water), and operates at ambient temperatures, significantly reducing energy consumption and toxic byproducts. The resulting NPs, endowed with a "green corona," have shown enhanced antimicrobial activity (Unuata *et al.,* 2025). This approach connects plant biodiversity (source of extract) with industrial innovation (production of nanomaterials) in an environmentally benign loop. It demonstrates how leveraging plant biochemistry can transform a potentially polluting technological process into a sustainable one, benefiting environmental health while producing useful materials for human health applications like antimicrobials.

From Waste to Resource: The Circular Economy of Plant Biomass. A holistic One Health view considers the entire

lifecycle. Plants used for phytoremediation of heavy metals (hyperaccumulators) face the challenge of disposal. However, this "contaminated biomass" need not become hazardous waste. Research into the thermal or chemical processing of such biomass is exploring ways to safely recover metals or convert the plant matter into bioenergy. While our studies have not directly addressed this, the principle is critical. It encourages a systems-thinking approach: a plant like *A. garckeana* could be cultivated on Mn-contaminated soil (remediation), its leaves or fruits harvested for hepatoprotective extract production (human health), and its residual biomass processed for metal recovery or energy. This circular model maximizes value, minimizes waste, and addresses multiple health determinants simultaneously cleaning the environment, providing medicine, and generating sustainable energy.

Synthesis for Environmental One Health. The evidence reviewed here, though preliminary from an applied environmental science standpoint, establishes a compelling biochemical rationale for deeper investigation. The plants in our research portfolio are not passive victims of contamination; their chemistry shows they are active responders. This insight allows us to reframe them as:

1. Candidate Phytoremediators: Species like *A. garckeana* and *B. ferruginea* are prime candidates for field trials on Mn- and Cd-contaminated sites, respectively.
2. Green Chemical Factories: Their extracts provide sustainable pathways for synthesizing nanomaterials, reducing the ecological footprint of a key industry.
3. Components of Circular Systems: They can be integrated into models that couple land remediation with the production of valuable botanical products.

Thus, the same biochemical properties that make a plant therapeutic internally may also enable it to act as an environmental janitor externally. Investing in the further study of these dual capacities is a direct investment in planetary health, creating tools to clean polluted environments while simultaneously discovering new medicines a truly synergistic One Health outcome.

CONSERVING BIODIVERSITY AND INDIGENOUS KNOWLEDGE AS VITAL HEALTH INFRASTRUCTURE

The first two pillars of this One Health synthesis protecting human health and remediating environments are entirely dependent on a stable, diverse, and accessible foundation: the continued existence of the plant species themselves and the accumulated wisdom regarding their use. Biodiversity is not merely an ecological luxury; it is the world's most extensive and sophisticated chemical library, most of which remains uncatalogued by science. Similarly, indigenous and local knowledge systems represent millennia of empirical research and testing. The erosion of either constitutes a catastrophic loss of health infrastructure with direct repercussions for human, environmental, and even economic resilience. Our research program, by providing scientific validation to traditional uses and revealing novel phytochemical wealth, underscores the urgent imperative for their conservation.

Phytochemical Wealth as a Justification for Conservation: The economic and health value of a species is a powerful argument for its preservation. Our detailed nutritional and phytochemical profiling of underutilized crops like velvet bean (*Mucuna pruriens*) and African eggplant (*Solanuma ethiopicum*) transformed them from traditional staples into recognized "nutraceuticals" (Adewuyi *et al.,* 2025). We documented their high densities of protein, essential amino acids, antioxidants, vitamins, and minerals. This quantitative data provides a concrete, science-based answer to the question, "Why conserve this plant?" It demonstrates that biodiversity harbors direct, measurable solutions to contemporary health challenges like protein-energy malnutrition and micronutrient deficiencies. Conservation then shifts from an abstract ecological goal to a strategic investment in bioprospecting for nutritional security. Every species lost represents a potentially unique combination of bioactive compounds that might have addressed a future health crisis, a loss that is irreversible.

Ethnobotanical Knowledge: The Indispensable Roadmap. Our investigations did not begin with random screening; they were guided by ethnobotanical leads. The selection of Euphorbia hirta and *Leptadenia hastata* for hypertension studies (Fagbohun *et al.,* 2025; Adewuyi *et al.,* 2020), *Telfairia occidentalis* for chemoprevention (Adewuyi *et al.,* 2025), and *Azanza garckeana* for liver ailments (Yusuf *et al.,* 2023) was informed by their established roles in traditional medicine. This knowledge system is the result of long-term, place-based observation and experimentation---a form of scientific inquiry in its own right. It dramatically increases the efficiency of drug discovery, providing pre-tested leads with a higher probability of biological activity. The erosion of this knowledge, due to cultural assimilation, land displacement, and the passing of elder generations, is as great a tragedy as species extinction. It severs the link between a community and its environmental pharmacy, diminishing local health sovereignty and depriving global science of a priceless intellectual resource. Our work, which translates this traditional knowledge into the language of modern biochemistry, serves to legitimize and help preserve it, showing its continued relevance in a scientific age.

Biodiversity Loss as a Direct Threat to One Health Resilience: The current mass extinction event, driven by habitat loss, climate change, and overexploitation, is a slow-motion health emergency. A less diverse ecosystem is less resilient to pests, diseases, and climate shocks, which in turn threatens food security and increases the likelihood of pathogen spillover from wildlife to humans a core One Health concern. From a medicinal perspective, a simplified landscape means fewer genetic options for future medicines. The COVID-19 pandemic highlighted our vulnerability to novel pathogens; similarly, we are vulnerable to novel diseases for which our current pharmacopeia may be inadequate. The next antiviral or anticancer breakthrough may be locked in the genome of a yet-unnamed plant in a threatened rainforest. Conserving biodiversity is therefore a form of pre-emptive biosecurity, maintaining the raw material for future health solutions.

Scientific Validation as a Tool for Conservation Advocacy: Research like ours plays a crucial role in conservation by adding value. By demonstrating that a locally used plant has potent antihyperglycemic, hepatoprotective, or antimicrobial properties, we increase its perceived worth beyond its immediate community. This can motivate:

1. Cultivation and Domestication: Moving a species from wild harvesting to controlled cultivation, reducing pressure on wild populations.

2. Policy Protection: Providing evidence for including a species in protected area management plans or national biodiversity strategies.

3. Community Incentive: Empowering local communities by validating their knowledge, potentially leading to benefit-sharing agreements if commercial products are developed.

In this way, biochemical research becomes an active agent in conservation, creating a positive feedback loop: traditional knowledge guides science, science validates and adds value, and this enhanced value incentivizes the protection of both the species and the knowledge.

Synthesis: An Integrated Conservation-Health Nexus. The interconnectedness is clear: human health relies on medicines from plants; environmental health relies on plants for ecosystem services; and both rely on the conservation of biodiversity and the knowledge to use it. Our research, spanning from the laboratory bench to the field of ethnobotany, exemplifies this nexus. It shows that investing in the scientific study of medicinal plants is simultaneously an investment in health discovery, environmental sustainability, and cultural preservation. A true One Health strategy must, therefore, explicitly include and fund biocultural conservation the integrated protection of species and the associated knowledge systems as a fundamental pillar of global health security. The loss of a single plant species and its traditional uses is not just an ecological or cultural loss; it is the burning of a library of potential cures before we have even read the books.

DISCUSSION

This review has traversed the three interconnected domains of the One Health triad human, environmental, and ecosystem/knowledge health using the biochemistry of indigenous medicinal plants as the unifying thread. The evidence synthesized demonstrates that these plants are not simple therapeutic agents but complex, multi-functional entities whose value extends far beyond the pharmacology laboratory. They emerge as potential nexus points for integrated solutions. The critical challenge and opportunity now lie in moving from demonstrating parallel potentials in siloed disciplines to designing and implementing truly synergistic interventions and research programs that acknowledge and exploit these interconnected roles.

The Case of *Azanza garckeana*

The journey of a single plant, *Azanza garckeana*, within this review illustrates the power of an integrated One Health perspective. Our research shows:

· ***Human Health Application:*** Its fractions protect the liver from manganese-induced toxicity (Yusuf *et al.*, 2023).

· ***Environmental Health Implication:*** The biochemical mechanism (chelating/antioxidant action) suggests a potential for phytostabilization or phytoextraction of manganese from contaminated soils, warranting direct agronomic and environmental testing.

· ***Biodiversity/Knowledge Health Action:*** Its validated efficacy provides a strong scientific rationale for its conservation through cultivation, protecting both the genetic resource and the associated ethnobotanical knowledge.

An integrated intervention, therefore, could involve: cultivating *A. garckeana* on marginally productive or Mn-contaminated land (environmental remediation); training local farmers in its sustainable harvest; processing the biomass to produce a standardized hepatoprotective supplement for at-risk communities (human health); and using the revenue or health benefits to incentivize further cultivation and the documentation of traditional knowledge (biocultural conservation). This model creates a virtuous cycle, addressing multiple determinants of health simultaneously and creating sustainable value from a local resource.

The Imperative for Transdisciplinary Research Design

The current state of the evidence, while compelling, is largely retrospectively integrated. The human health studies were not designed with phytoremediation assays in mind, and the environmental potential is an inference from therapeutic mechanisms. To fully realize the One Health promise, future research must be prospectively transdisciplinary. This means:

· ***Collaborative Teams from the Outset:*** Research proposals should co-include pharmacologists, environmental chemists, agronomists, ethnobotanists, and social scientists.

· ***Multi-Endpoint Study Designs:*** A study on a plant for metal toxicity should include, in parallel, assays to measure the plant's metal uptake capacity in contaminated soil, its impact on soil microbial health, and its biomass yield.

· ***Respectful Engagement with Knowledge Holders:*** Indigenous communities and traditional healers must be engaged as equal partners, not merely as sources of information, ensuring benefit-sharing and that research aligns with community priorities.

This approach would generate a richer, more immediately applicable dataset. For instance, screening plants for antimicrobial activity could concurrently assess their effects on soil-borne plant pathogens, linking human and plant health directly.

Limitations and Critical Knowledge Gaps

Acknowledging limitations is essential for charting a credible path forward. The primary limitation of the work synthesized here is its preclinical and inferential nature regarding environmental and systemic impacts. While rat models are excellent for mechanistic insight, they do not predict field efficacy in phytoremediation or the complex socio-ecological outcomes of conservation interventions. Specific gaps include:

- ***Lack of Field Data:*** No direct measurements of metal uptake by *A. garckeana* or *B. ferruginea* in contaminated field sites.
- ***Uncertain Environmental Fate:*** The long-term ecological impact of cultivating these plants for mass harvest, or the disposal of metal-laden biomass, is unknown.
- ***Scalability and Socioeconomics:*** The economic viability, supply chain logistics, and social acceptability of scaling up integrated interventions have not been studied.

Addressing these gaps requires moving boldly from the controlled lab environment to the complex, "messy" reality of field trials and pilot implementation projects.

A Forward-Looking Agenda: Research, Policy, and Practice

To translate this One Health vision into reality, a coordinated agenda is needed:

1. ***Research Priority:*** Fund and conduct proof-of-concept pilot projects that integrate cultivation for phytoremediation with the production of standardized botanical extracts. These should include rigorous environmental monitoring, clinical safety/efficacy studies in exposed populations, and socioeconomic impact assessments.
2. ***Policy Innovation:*** Governments and international agencies need to develop cross-ministerial policies that connect the mandates of health, environment, agriculture, and science/technology. Incentives for cultivating multi-purpose medicinal plants on degraded lands could be a powerful policy tool.
3. ***Educational Reform:*** Universities should develop One Health-focused curricula that train the next generation of scientists to think and work across traditional disciplinary boundaries, valuing both laboratory science and field-based, community-engaged research.
4. ***Global Frameworks:*** Integrate the conservation and sustainable use of medicinal plants explicitly into the implementation of international agreements like the UN Convention on Biological Diversity (CBD) and the Sustainable Development Goals (SDGs), particularly those related to health (SDG 3), responsible consumption (SDG 12), and life on land (SDG 15).

Viewing medicinal plants through a One Health lens is not merely an academic exercise; it is a pragmatic reorientation towards efficiency, sustainability, and resilience. This synthesis has shown that the biochemical properties that make a plant a good medicine may also make it a good environmental cleaner and a strong candidate for conservation. By breaking down the silos between pharmacology, environmental science, and ethnobotany, we can design interventions that heal people, restore land, and preserve vital knowledge and biodiversity in a single, integrated effort. The plants themselves have always existed at this nexus. It is now incumbent upon our research paradigms, policies, and practices to catch up, fostering a transdisciplinary collaboration worthy of the complex, interconnected health challenges we face.

CONCLUSION

This narrative review has demonstrated that the biochemical investigation of indigenous medicinal plants is a foundational activity for One Health. By synthesizing evidence across three interconnected domains, we have shown that plants like *Azanza garckeana*, *Vernonia amygdalina*, and Sennaoccidentalis are more than potential medicines; they are versatile, living systems offering integrated solutions. They can protect human health from environmental and infectious threats, contribute to environmental decontamination through phytoremediation and green synthesis, and their very existence and traditional use underscore the non-negotiable value of conserving biodiversity and indigenous knowledge. The true power of this perspective lies in integration. Future efforts must pivot from siloed research to deliberately designed transdisciplinary programs that evaluate therapeutic, environmental, and conservation outcomes simultaneously. By doing so, we can develop resilient, place-based strategies that heal communities, restore ecosystems, and safeguard the biological and cultural libraries essential for our collective future health. Embracing this holistic view is not an option but a necessity for building sustainable health security in an interconnected world.

Declarations

Ethics Approval and Consent to Participate

This article is a narrative review and synthesis of published research.

Consent for Publication

Not applicable.

Data Availability Statement

The datasets supporting the conclusions of the individual studies synthesized in this review are available from the corresponding author of each respective original publication upon reasonable request.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review.

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Authors' Contributions

Timileyin Joshua Oluwadepo: Conceptualized the review, curated and synthesized the body of work, wrote the original draft, and reviewed/edited the final manuscript. All other co-authors of the original studies contributed to the data generation, analysis, and manuscript preparation of their respective cited works. All authors read and approved the final version of this synthesis.

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