



**PUBLIC HEALTH APPLICATIONS
OF MEDICINAL PLANT
BIOCHEMISTRY: EVIDENCE FOR
PRIMARY PREVENTION, DISEASE
MANAGEMENT, AND MITIGATION
OF TREATMENT TOXICITY**

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Introduction

The mandate of public health has decisively expanded beyond the traditional control of infectious epidemics. It now encompasses the complex challenge of managing the rising global burden of non-communicable diseases (NCDs), mitigating environmental health risks, and ensuring the sustainability of health systems under demographic and economic pressures (Horton, 2018; Frenk and Moon, 2013). This broadened scope is best conceptualized through a continuum of care model, which strategically integrates three critical phases: primary prevention and health promotion, acute disease intervention and management, and long-term supportive care including the mitigation of treatment-related harm (World Health Organization, 2018). This model provides a coherent framework for deploying resources efficiently and improving health

Abstract

Public health strategies are evolving from a singular focus on treatment to embrace a holistic continuum encompassing prevention, acute management, and long-term supportive care. This evolution creates a critical demand for safe, accessible, and multifunctional interventions. This narrative review synthesizes evidence from a sustained biochemical research program to map the applications of indigenous Nigerian medicinal plants and functional foods onto this public health continuum. Findings are presented demonstrating their efficacy in: (1) Primary Prevention & Health Promotion, including the use of *Carica papaya* to combat nutritional anemia and *Telfairia occidentalis*

for chemoprevention; (2)

Keywords: Public Health Continuum, Primary Prevention, Disease Management, Supportive Care, Phytomedicines, Health Systems, Biochemical Translation.

Acute Disease Intervention & Management, highlighting the hepatorenal protection offered by *Azanza garckeana* against manganese toxicity and the antimicrobial activity of green-synthesized nanoparticles from *Senna occidentalis*; and (3) Supportive Care & Mitigation of Iatrogenic Harm, evidenced by the capacity of *Zingiber officinale* and *Gongronema latifolium* to attenuate

chemotherapy-induced toxicities. The review argues that the biochemical properties of these plants particularly their antioxidant, anti-inflammatory, and antimicrobial mechanisms make them versatile tools for public health. By systematically organizing this evidence according to the stage of health intervention, a practical framework is provided for policymakers, health planners, and practitioners to integrate evidence-based phytomedicines into structured public health programs, from community-wide prevention campaigns to clinical supportive care protocols, ultimately building more resilient and responsive health systems.

Outcomes across the lifespan of individuals and populations. However, implementing this comprehensive model, particularly in low- and middle-income countries (LMICs), faces significant constraints. These include limited access to expensive pharmaceuticals, the crisis of antimicrobial resistance (AMR), the high cost of managing chronic diseases and cancer therapy side effects, and infrastructural gaps in healthcare delivery (Ghebreyesus, 2017; Laxminarayan *et al.*, 2013). Consequently, there is a pressing need to identify and validate complementary, cost-effective, and culturally resonant interventions that can strengthen each phase of this continuum.

Medicinal plants and functional foods, deeply embedded in the sociocultural fabric of many LMICs, represent a vast, under-utilized reservoir of such interventions. Their biochemical constituents' phenolic acids, flavonoids, alkaloids, and terpenoids possess a

wide array of pharmacologically relevant properties, including antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and chemomodulatory activities (Ruwizhi and Aderibigbe, 2020; Sova and Saso, 2020). While a substantial body of preclinical research documents these activities, the evidence often remains siloed, failing to articulate a clear narrative for public health application. The critical question is not merely if a plant has bioactive properties, but how and when in the public health continuum these properties can be most effectively leveraged.

This narrative review addresses this translational gap. It synthesizes findings from our multi-year biochemical and pharmacological research program to explicitly map the potential of selected indigenous plants onto the three pillars of the public health continuum. Our objective is threefold: first, to curate and present our evidence according to its stage-specific applicability (prevention, management, supportive care); second, to elucidate the cross-cutting biochemical mechanisms that enable this versatility; and third, to propose a concrete framework for integrating these evidence-based phytomedicines into public health planning and practice. We contend that a deliberate, stage-specific application of phytochemical knowledge can significantly enhance the efficiency, reach, and resilience of public health systems, offering pragmatic solutions for some of their most persistent challenges.

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METHODOLOGY AND SEARCH STRATEGY

To ensure transparency and representativeness, this review utilized a systematic search of major electronic databases, including PubMed, Google Scholar, ScienceDirect, and the African Journals OnLine (AJOL). The search strategy focused on peer-reviewed literature published between 2019 and 2025, using keywords such as 'medicinal plant biochemistry,' 'Nigerian indigenous plants,' 'public health prevention,' and 'iatrogenic harm mitigation.' Plants were selected for inclusion based on their prevalence in Nigerian ethnomedicine and the availability of rigorous biochemical data from sustained research programs. This strategy ensures that the synthesis reflects verified biochemical efficacy rather than a convenience selection of results."

PRIMARY PREVENTION AND HEALTH PROMOTION

The most efficient and cost-effective public health strategy is to prevent disease from occurring in the first place. Primary prevention focuses on reducing risk factors and promoting health among healthy populations. In many settings, this involves tackling foundational issues like malnutrition, exposure to dietary carcinogens, and the early stages of metabolic dysregulation. Our research highlights how specific, locally available plants can serve as powerful tools in this preventive arsenal, moving individuals from a state of vulnerability to one of biochemical resilience.

Combating Nutritional Deficiencies: The Case of Carica papaya in Anemia. Iron-deficiency anemia remains a massive global health challenge, impairing cognitive development in children and reducing economic productivity in adults. While iron supplementation is standard, its success is often limited by poor compliance and side effects. Our work offers a complementary, food-based approach. In a preclinical model of induced anemia, constituents from unripe *Carica papaya* particularly its alkaloids and flavonoids demonstrated a remarkable ability to restore normal blood parameters (Adewuyi *et al.*, 2024). While these results are compelling, the integration of such findings into public health requires an awareness of conflicting data in varied ethnobotanical contexts and a deeper engagement with the specific effect sizes observed in dietary interventions to ensure clinical relevance.

The intervention did more than just potentially provide iron; it appeared to protect red blood cells from oxidative damage and create a favorable environment for their production. For public health practitioners, this suggests that promoting the consumption of papaya, a culturally accepted and widely cultivated fruit, could be a sustainable strategy woven into nutrition education programs. It represents a shift from relying solely on pharmaceutical supplements to strengthening the body's own hematological system through diet.

Dietary Chemoprevention with Telfairia occidentalis: Cancer prevention is a paramount public health goal, and diet is one of its most modifiable levers. We investigated the fluted pumpkin (*Telfairia occidentalis*), a leafy green vegetable staple in West African diets, for its potential to prevent breast cancer in an experimental model (Adewuyi *et al.*, 2025a). When animals received the plant extract alongside a potent carcinogen, the development of mammary tumors was significantly reduced. Biochemically, the extract mitigated the severe oxidative stress and inflammation triggered by the carcinogen. This finding is powerful for public health messaging: a regular dietary component, not an exotic supplement, may carry inherent cancer-protective properties. Encouraging higher consumption of such traditional vegetables, through agricultural and culinary initiatives, becomes a viable population-level strategy for reducing cancer risk, aligning with global recommendations for plant-rich diets.

Unlocking the Nutraceutical Potential of Local Crops: True food security means not just having enough calories, but enough nutrient-rich calories. Our detailed biochemical profiling of underutilized crops like velvet bean (*Mucuna pruriens*) and African eggplant (*Solanum aethiopicum*) revealed their exceptional value (Adewuyi, 2025). These plants were found to be dense in proteins, essential vitamins, antioxidants, and minerals. By

scientifically validating their nutritional profiles, we move them from being mere traditional foods to being recognized as "nutraceuticals" -- foods with defined health benefits. Public health interventions can leverage this data to promote dietary diversification. Agricultural extension services can encourage the cultivation of these nutritious crops, and community health workers can educate families on their benefits, directly addressing the "hidden hunger" of micronutrient deficiencies that underpin so much chronic disease.

Modulating Cardiovascular Risk with Herbal Antihypertensives: Hypertension is a silent precursor to stroke, heart attack, and kidney failure. Managing it at the pre-hypertensive or early stage is a critical prevention goal. Our preclinical studies on *Euphorbia hirta* and *Leptadenia hastata* provide scientific support for their traditional use in managing blood pressure (Fagbohun *et al.*, 2025a; Adewuyi *et al.*, 2020). In models simulating stress-induced hypertension, these plant extracts effectively lowered blood pressure and corrected associated unhealthy blood thickening. The likely mechanisms involve promoting blood vessel relaxation and reducing physiological stress responses. For public health, this evidence supports the development of culturally acceptable, low-cost preventive options. Standardized, safe preparations of these plants could be recommended as part of lifestyle counseling for individuals with borderline hypertension, potentially delaying or preventing the need for lifelong pharmaceutical therapy and reducing the future burden on the healthcare system.

Synthesis for Public Health Action: Collectively, this body of work (Adewuyi *et al.*, 2024; Adewuyi *et al.*, 2025a; Adewuyi, 2025; Fagbohun *et al.*, 2025a; Adewuyi *et al.*, 2020) provides a strong, evidence-based rationale for integrating specific plants into primary prevention programs. The public health translation is clear:

1. Nutrition Programs: Integrate *C. papaya* and nutrient-dense crops like *M. pruriens* into strategies aimed at combating anemia and malnutrition.
2. Cancer Prevention Campaigns: Include messages about the protective value of traditional leafy greens like *T. occidentalis*.
3. Cardiovascular Health Initiatives: Develop community guidelines on the supportive use of validated herbs like *E. hirta* for early blood pressure management alongside diet and exercise.

These are not hypothetical interventions but are grounded in demonstrated biochemical efficacy. By building community knowledge and access around these functional resources, public health can shift its focus from treating advanced disease to proactively building a healthier, more resilient population.

ACUTE INTERVENTION AND DISEASE MANAGEMENT

When prevention falls short and disease manifests, public health systems must provide effective and accessible management strategies. This is especially critical for acute toxic exposures, infectious diseases, and the control of chronic metabolic conditions. In resource-limited settings, conventional treatments can be unavailable, unaffordable, or compromised by issues like antimicrobial resistance. Our research provides compelling

evidence that phytochemicals can play a vital role in this acute intervention phase, offering effective alternatives or adjuncts for managing active disease.

Managing Environmental Toxicities. The Hepatorenal Protective Role of *Azanza garckeana*. Acute and sub-acute poisoning from environmental heavy metals like manganese (Mn) is a serious occupational and environmental health concern. Our work demonstrates that intervention with plant-based agents during exposure can significantly mitigate damage. In a model of Mn-induced hepatotoxicity, co-treatment with fractions from *Azanza garckeana* provided substantial protection (Yusuf et al., 2023). The plant treatment effectively countered the Mn-induced surge in oxidative stress markers and prevented the depletion of the liver's intrinsic antioxidant defenses, such as glutathione. This suggests a direct bioremediative effect, where plant compounds neutralize toxic radicals and support the organ's own detoxification pathways. For public health, this points to a practical strategy: in communities or industries with known heavy metal exposures, prophylactic or early interventional use of standardized plant extracts could be incorporated into occupational health protocols to reduce the incidence of chronic toxic injuries, acting as a biological shield for at-risk workers.

Addressing the Antimicrobial Resistance Crisis with Plant-Derived Solutions. The rise of drug-resistant bacteria represents a profound failure in the management of infectious diseases, pushing us toward a post-antibiotic era. Our investigations into plants like *Chromolaena odorata* and *Maytenus heterophylla* have identified potent, broad-spectrum antibacterial activity in their phenolic and flavonoid-rich fractions (Fagbohun et al., 2025b; Umar et al., 2019). These compounds often attack microbial cells through mechanisms distinct from conventional antibiotics such as disrupting cell membranes or inhibiting virulence factors making them promising candidates against resistant strains. Furthermore, we advanced this concept by using *Senna occidentalis* extracts to green-synthesize silver and zinc oxide nanoparticles (Unuata et al., 2025). These biosynthesized nanoparticles exhibited enhanced antimicrobial potency, likely due to a synergistic combination of the metal's intrinsic toxicity and the bioactive phytochemical corona from the plant. The public health application is clear: developing standardized topical formulations from these plants or their nanohybrids could provide much-needed, effective first-line treatments for skin and wound infections in community settings. This could reduce reliance on systemic antibiotics, slow the spread of resistance, and offer affordable care where modern antibiotics are scarce or ineffective.

Glycemic and Metabolic Control with Vernonia amygdalina in Diabetes. Diabetes management requires constant intervention to control blood glucose and lipid levels, preventing acute complications and long-term organ damage. Our study on *Vernonia amygdalina* (bitter leaf) in an alloxan-induced diabetic model showed its potent multi-target effects (Ogar et al., 2025). The extract significantly lowered elevated blood glucose and harmful lipids (hyperlipidemia), while also protecting the liver from diabetic injury and boosting antioxidant status. This multi-pronged activity is ideal for managing a complex metabolic disorder. For public health, this validates a commonly consumed vegetable as a functional dietary adjunct in diabetes care. Healthcare providers can confidently counsel patients to incorporate *V. amygdalina* into their diets as part of a

holistic management plan. In contexts where access to the full spectrum of glucose-lowering drugs is limited, promoting such dietary strategies becomes an essential component of disease control programs.

Synthesis for Public Health Action. The studies in this phase (Yusuf *et al.*, 2023; Fagbohun *et al.*, 2025b; Umar *et al.*, 2019; Unuata *et al.*, 2025; Ogar *et al.*, 2025) demonstrate that plant-based interventions are not merely preventive but are robust enough for active disease management. The public health implications are operational:

1. Environmental Health Protocols: Develop response kits containing standardized hepatoprotective plant extracts (like *A. garckeana*) for communities with known toxic exposure risks.
2. Infection Control Programs: Introduce approved topical antiseptics based on plants like *C. odorata* or biosynthesized nanoparticles into primary health clinics and community health worker kits for treating localized infections.
3. Chronic Disease Management Guidelines: Integrate specific, evidence-based functional foods like *V. amygdalina* into dietary counseling protocols for diabetes and metabolic syndrome patients at public health clinics.

This body of work shifts the narrative from viewing phytomedicines as mere traditional support to recognizing them as valid first-line or adjunctive therapeutic agents within integrated public health responses to active disease. Their local availability and cultural acceptance make them uniquely suited to strengthen health systems at the point of care.

SUPPORTIVE CARE AND MITIGATION OF IATROGENIC HARM

The public health mandate extends beyond curing disease to ensuring that treatment itself does not create undue suffering or new health burdens. This phase supportive care is critical for managing the side effects of potent therapies like chemotherapy, improving patient quality of life, and ensuring treatment adherence. Iatrogenic harm, or injury caused by medical intervention, is a significant challenge, particularly in oncology and chronic disease management. Our research demonstrates that phytochemicals can play a vital, protective role here, safeguarding patients from the toxic side effects of essential drugs and supporting systemic recovery, thereby completing the continuum of care.

Shielding from Chemotherapy Toxicity: Zingiber officinale and Cisplatin. Cisplatin is a cornerstone chemotherapeutic agent, but its severe nephrotoxic and myelosuppressive effects often limit its use and diminish a patient's quality of life. Our investigation into *Zingiber officinale* (ginger) juice extract revealed its significant protective potential (Adewuyi *et al.*, 2025b). In a rat model, ginger co-treatment effectively attenuated the cascade of cisplatin-induced damage: it reduced oxidative stress in kidneys and blood cells, mitigated the drop in critical blood cell counts, and helped normalize disrupted reproductive hormones. Ginger's rich profile of gingerols and shogaols, known for their anti-inflammatory and antioxidant properties, likely neutralizes the free radicals generated by cisplatin and modulates inflammatory pathways. For public health oncology, this is highly actionable evidence. Integrating standardized ginger supplementation into supportive care protocols could allow for safer administration of full-dose cisplatin regimens, improve patient outcomes, and reduce the need for costly interventions to

manage side effects. It represents a low-cost, high-impact strategy to make essential cancer care more tolerable and sustainable.

Mitigating Long-Term Drug Side Effects: Gongronema latifolium and Tamoxifen. The management of chronic conditions like hormone-receptor-positive breast cancer involves long-term drug use, which carries its own risks. Tamoxifen, while lifesaving, is associated with an increased risk of thromboembolism and metabolic syndrome. Our study on Gongronema latifolium showed that its extract could counteract tamoxifen-induced oxidative stress and inflammation in cardiac and hepatic tissues (Fagbohun *et al.*, 2025a). This suggests that the plant does not interfere with tamoxifen's anticancer action but instead provides a layer of metabolic and cardiovascular protection. In public health terms, this supports the concept of adjuvant phytotherapy using plants concurrently with chronic medications to manage their deleterious side-effect profiles. Recommending or providing access to such supportive botanicals can improve long-term adherence to essential drugs and protect patients from developing secondary chronic diseases as a consequence of their treatment.

Establishing Safety for Chronic Supportive Use: The Case of Albizia lebbeck and Curcuma longa. Before any intervention can be widely recommended for supportive care, its safety profile must be established. Our sub-chronic toxicity study on Albizia lebbeck and Curcuma longa (turmeric) is foundational for this purpose (Fagbohun *et al.*, 2025c). The research confirmed that these botanicals, at therapeutic doses for improving gastrointestinal motility, did not induce adverse effects on major organ function or hematological parameters. This demonstration of safety is arguably as important as the demonstration of efficacy for public health translation. It provides the necessary confidence for healthcare providers to recommend these plants for managing common, treatment-related issues like chemotherapy-induced nausea or constipation, without fear of causing additional harm. It moves these remedies from the realm of anecdotal tradition to that of evidence-based supportive care.

Synthesis for Public Health Action: This cluster of work (Adewuyi *et al.*, 2025b; Fagbohun *et al.*, 2025a; Fagbohun *et al.*, 2025c) addresses a often-overlooked but crucial component of the health continuum: care after the cure, and protection during treatment. The public health applications are directly relevant to clinical and community care:

1. Oncology Support Protocols: Develop and disseminate guidelines for the use of ginger supplements to manage chemotherapy-induced nephro- and myelotoxicity in cancer treatment centers.
2. Chronic Disease Adjunct Therapy: Incorporate evidence on plants like G. latifolium into patient education materials for those on long-term medications like tamoxifen, framing them as protective allies.
3. Safety-First Formularies: Create a "Green List" of medicinal plants with robust safety data (like A. lebbeck and C. longa) for use in managing common side effects within primary healthcare settings.

By scientifically validating these supportive roles, we empower health systems to offer more holistic care. This approach not only treats the primary disease but also actively

preserves the patient's overall health during and after treatment, reducing the overall burden of iatrogenic illness and improving the human experience of healthcare.

DISCUSSION

This narrative review has organized a diverse body of biochemical research according to a fundamental public health model: the continuum of care. By mapping evidence onto the stages of Primary Prevention, Acute Intervention, and Supportive Care, we have moved beyond a simple catalog of biological activities. Instead, we have constructed a pragmatic framework that shows when and for what purpose specific medicinal plants and functional foods can be most effectively deployed within a health system. This final synthesis highlights the unifying scientific principles, underscores the strategic value of this staged approach, and outlines the path from evidence to integrated public health practice.

CHALLENGES IN IMPLEMENTATION AND POLICY INTEGRATION

The transition from biochemical evidence to public health application requires addressing significant practical challenges. Standardizing plant-based extracts is essential for ensuring dosage consistency across different batches, which is a major hurdle for large-scale public health use. Furthermore, the shelf-life and stability of functional foods, such as processed *Telfairia occidentalis*, must be scientifically established to ensure they remain effective during storage and community-wide distribution. Integrating these findings into Nigerian national health policies will require clearly defined regulatory pathways and collaboration with bodies like NAFDAC to move these interventions from laboratory validation to clinical and community-based protocols."

UNIFYING BIOCHEMICAL THEMES ACROSS THE CONTINUUM

The efficacy of the reviewed plants across all three stages is underpinned by a consistent set of biochemical mechanisms, primarily centered on modulating oxidative stress and inflammation. This is not a coincidence but a reflection of these pathways' fundamental role in the pathogenesis of most diseases, from carcinogenesis and toxin injury to infection and drug toxicity.

- In Primary Prevention, the antioxidant and anti-inflammatory properties of *Telfairia occidentalis* likely disrupt the early cellular changes that lead to cancer (Adewuyi *et al.*, 2025a), while similar properties in *Euphorbia hirta* contribute to maintaining vascular health and preventing hypertension (Fagbohun *et al.*, 2025a).
- In Acute Intervention, these same mechanisms are harnessed to manage active damage. *Azanza garckeana* counters the pro-oxidant assault of manganese on the liver (Yusuf *et al.*, 2023), and the antimicrobial phenolics in *Chromolaena odorata* may also quench microbial-induced inflammatory cascades (Fagbohun *et al.*, 2025b).

- In Supportive Care, neutralizing oxidative stress is directly therapeutic, as seen when *Zingiber officinale* scavenges the free radicals generated by cisplatin, thereby protecting the kidneys and bone marrow (Adewuyi *et al.*, 2025b).

This mechanistic consistency is a major strength. It means that public health initiatives promoting a diet rich in these phytochemicals inherently build resilience that is applicable across multiple health challenges. A community educated on and having access to antioxidant-rich local foods is simultaneously arming itself against nutritional deficits, environmental toxins, and the side effects of necessary medical treatments.

THE VERSATILITY OF KEY PLANTS AND THE MULTI-USE PARADIGM

Several plants exemplify the multi-use potential central to efficient public health planning. *Curcuma longa* (turmeric) serves as a prime example: its curcuminoids act as acute hepatoprotectants against chemical toxins (Umar *et al.*, 2019), while the whole plant extract has been shown to be safe and beneficial for gastrointestinal motility, a common supportive care need (Fagbohun *et al.*, 2025c). Similarly, a plant like *Vernonia amygdalina* can be promoted for primary prevention of metabolic syndrome due to its antihyperglycemic effects (Ogar *et al.*, 2025), and also used as a dietary management tool for those already diagnosed with diabetes. This versatility transforms these plants from single-purpose remedies into public health assets that can be leveraged across different programs and for different population segments, maximizing return on investment in agricultural promotion, research, and community education.

TOWARD AN INTEGRATED PUBLIC HEALTH IMPLEMENTATION FRAMEWORK

The staged evidence presented here argues for a deliberate, phased integration of phytomedicines into health system planning. An integrated framework would involve:

- At the Community/Health Promotion Level: Focus on Primary Prevention tools. This includes agricultural policies supporting the cultivation of *Carica papaya*, *Mucuna pruriens*, and *Telfairia occidentalis*, and community health worker-led education on their specific health-promoting roles.
- At the Primary Healthcare Clinic Level: Equip facilities with Acute Intervention and Supportive Care tools. This could involve stocking standardized topical antimicrobials based on *C. odorata* or biosynthesized nanoparticles for wound care, and having protocols for recommending ginger supplements to patients starting cisplatin-based chemotherapy.
- At the Health System Policy Level: Develop formularies and treatment guidelines that include evidence-based phytotherapeutic options for specific indications, such as adjuvant use of *Gongronema latifolium* for patients on tamoxifen or the use of *Azanza garckeana* extracts in occupational health programs for at-risk workers.

This framework ensures that the right botanical tool is available at the right point in the care pathway, from the healthy community member to the patient undergoing intense treatment.

LIMITATIONS AND CRITICAL NEXT STEPS

The primary limitation of this synthesis, and the field in general, is the preclinical nature of much of the evidence. While animal models provide indispensable mechanistic insight, they are not a substitute for human data. The promising safety profile of many plants (Fagbohun et al., 2025c) provides a foundation, but it is not a guarantee of efficacy in human populations.

Therefore, the future agenda is unequivocal:

1. Targeted Clinical Research: Priority must be given to well-designed human trials (RCTs) for the most promising applications, such as ginger for chemotherapy-induced nausea/renal protection, or standardized *E. hirta* extracts for stage I hypertension.
2. Safety and Interaction Studies: Rigorous investigation of potential herb-drug interactions is essential, especially for plants intended for supportive care during complex drug regimens.
3. Implementation Science: Research must explore how to best integrate these interventions into existing health systems addressing supply chains, training healthcare workers, ensuring quality control, and measuring cost-effectiveness.

Viewing medicinal plant biochemistry through the lens of the public health continuum transforms isolated findings into a strategic blueprint for action. The evidence synthesized here demonstrates that these natural resources are not merely relics of traditional practice but are sophisticated, multi-purpose tools capable of strengthening every link in the chain of care. By adopting a staged, evidence-based approach to their integration promoting them for prevention, utilizing them for management, and applying them for support health systems, particularly in resource-conscious settings, can become more resilient, responsive, and holistic. The journey from biochemical mechanism to community health impact is complex, but this review charts a clear and rational course forward, arguing that the deliberate cultivation of both plants and this knowledge is essential for the future of equitable public health.

CONCLUSION

This narrative review has demonstrated that the biochemical investigation of indigenous medicinal plants transcends academic inquiry to offer a practical, staged framework for strengthening public health systems. By organizing evidence from a cohesive research program according to the continuum of care encompassing primary prevention, acute disease management, and supportive care we have moved from listing biological activities to proposing a strategic deployment plan. The work shows that plants like *Carica papaya*, *Azanza garckeana*, and *Zingiber officinale* are not simple remedies but versatile public health assets. Their core mechanisms, particularly the mitigation of oxidative stress and inflammation, make them effective across the spectrum of health needs, from building population-wide resilience against anemia and environmental toxins to managing active infections and protecting patients from the harsh side effects of essential therapies. The imperative now is for integrated action. Researchers must prioritize clinical trials to solidify the human evidence base. Policymakers and health planners should use this

staged framework to guide the thoughtful integration of standardized, safe phytotherapeutic options into national health programs, agricultural policies, and community health worker protocols. By doing so, we can leverage local biodiversity not as an alternative, but as a foundational component of more resilient, accessible, and holistic public health strategies for the 21st century.

DECLARATIONS

Ethics Approval and Consent to Participate

This article is a narrative review and synthesis of previously published research. All original studies cited herein were conducted in accordance with relevant national and institutional guidelines. Specific ethical approvals are referenced in the individual source publications.

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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