REVIEW ARTICLE

Journal of Public Health, Policy, and Society (JPHPS)
DOI: https://doi.org/10.54117/yjsw6h21

3(1): 101-111 (2026)

Translating Biochemical Research on Medicinal Plants into Public Health Strategies for Toxicity, Infection, and Chronic Disease

Oluwadepo, T. J.[1*], Osuji, C. A.[2], Utitofon, I. N.[3], Metu, E. C.[4], Onyebuchi, C. O.[5], Isa, J. M.[5], and Oyeyemi, A. O.

[1]Afriglobal Health Limited.
[2]Biochemistry Department, Gregory University Uturu Abia State.
[3] Naphdark Pharmacy Ltd.
[4]Department of Biochemistry, University of Nigeria Nsukka.
[5]Biotechnology Advanced Research Center, Sheda Science and Technology Complex (SHESTCO) KM 32 Abuja-Lokoja Expressway, Sheda Abuja.
[6]Diseases Prevention and Monitoring Department, eHealth Africa.

*Corresponding author e-mail address: timileyin.oluwadepo@afriglobalhealth.com

Received: *12 Jan 2026* ***Accepted:*** *15 Feb 2026* ***Published:*** *26 Feb 2026*

ABSTRACT

The global health landscape, particularly in resource-limited regions, is defined by a complex syndemic where infectious diseases, non-communicable diseases, and the consequences of environmental degradation intersect. Addressing this triple burden requires innovative, accessible, and sustainable strategies that extend beyond conventional pharmaceutical approaches. This narrative review synthesizes findings from a multi-year research program to construct a translational bridge between the biochemical analysis of indigenous medicinal plants and actionable public health interventions. Our work demonstrates that phytochemicals such as phenolic acids, flavonoids, and alkaloids from specific medicinal plants exert potent protective effects against heavy metal and chemical-induced hepatorenal toxicity. Furthermore, we document how functional foods can ameliorate nutritional anemias and modulate cancer risk. In the face of rising antimicrobial resistance, our research highlights the efficacy of plant-derived compounds and green-synthesized nanoparticles as promising antimicrobial agents. Additionally, certain plant extracts show significant antihypertensive potential, offering insights for managing cardiovascular disease. By integrating these discrete lines of evidence, this review argues that the systematic development of indigenous phytomedicines and nutraceuticals represents a viable, culturally attuned strategy for primary prevention and adjunct therapy. We conclude by outlining a translational roadmap, emphasizing the need for robust clinical validation, safety profiling, and the integration of evidence-based phytotherapeutic knowledge into primary healthcare frameworks to mitigate the multifaceted public health challenges of the 21st century.

How to cite this article
Oluwadepo, T. J., Osuji, C. A., Utitofon, I. N., Metu, E. C., Onyebuchi, C. O., Isa, J. M., & Oyeyemi, A. O. (2026). Translating biochemical research on medicinal plants into public health strategies for toxicity, infection, and chronic disease. *Journal of Public Health, Policy, and Society*, *3*(1), 101–111. https://doi.org/10.54117/yjsw6h21

Keywords
Public Health Translation; Medicinal Plants; Environmental Toxicology; Antimicrobial Resistance; Nutritional Biochemistry; Chronic Disease Prevention; Phytotherapy; Health Equity

INTRODUCTION

Contemporary public health faces a paradigm defined by simultaneity the concurrent and often synergistic prevalence of communicable diseases, a rapid epidemiological transition towards non-communicable diseases (NCDs), and persistent undercurrents of malnutrition and micronutrient deficiencies (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018; World Health Organization, 2021). This triple burden exerts a disproportionate toll on low- and middle-income countries (LMICs), where health systems are frequently strained and access to comprehensive care remains limited (Chang *et al.*, 2023). Compounding this challenge is the pervasive threat of environmental health risks. Population exposure to heavy metals (e.g., manganese, cadmium, lead) and persistent agrochemicals through contaminated air, water, and food chains is a silent contributor to chronic hepatorenal, neurological, and cardiovascular pathologies (Wang *et al.*, 2021; Dorman, 2023). The management of these intertwined health threats with solely conventional biomedical tools is fraught with obstacles, including cost, antimicrobial resistance (AMR), drug side effects, and often, sheer infrastructural inadequacy (Laxminarayan *et al.*, 2013).

In this context, there is a compelling public health rationale to explore complementary and integrative approaches that are accessible, sustainable, and rooted in local contexts (World Health Organization, 2013). Medicinal plants and dietary botanicals, integral to the cultural and healing traditions of many communities, represent an immense repository of bioactive compounds. Phytochemicals such as phenolic acids, flavonoids, alkaloids, and terpenoids are renowned for their diverse pharmacologic properties, including antioxidant, anti-inflammatory, chelating, and antimicrobial activities (Ruwizhi and Aderibigbe, 2020; Santos-Buelga *et al.*, 2023). Scientific validation of these traditional remedies offers a pathway to develop evidence-based, locally relevant interventions.

However, a significant translational gap persists. A vast body of research, including extensive preclinical biochemical and pharmacological studies, remains confined to laboratory reports, failing to coalesce into a narrative that explicitly informs public health policy or community-level action (Heinrich *et al.*, 2020). The journey from documenting a plant extract's in vitro

antioxidant capacity to implementing a community-based strategy for preventing metal toxicity is complex and requires deliberate synthesis.

This narrative review is conceived as an exercise in translational synthesis. It seeks to integrate findings from a coherent body of our own investigative work spanning studies on hepatoprotection, antimicrobial activity, nutritional intervention, cardiovascular modulation, and cancer chemoprevention into a unified public health argument. Our research, conducted over several years, has systematically evaluated the efficacy of Nigerian medicinal flora against health threats that mirror the very components of the triple disease burden (Adewuyi *et al.,* 2024; Fagbohun *et al.,* 2025; Adewuyi *et al.,* 2020; Yusuf *et al.,* 2023; Jonathan *et al.,* 2020; Adewuyi *et al.,* 2025a; Adewuyi *et al.,* 2025b). This review moves beyond a mere cataloging of biological effects. Instead, it aims to demonstrate how mechanistic biochemical insights, when logically assembled and interpreted through a public health lens, can illuminate practical strategies for disease prevention, health promotion, and potentially, tertiary care support.

We structure this synthesis around five interconnected thematic pillars that reflect both major public health priorities and the foci of our research: (1) countering environmental and occupational toxicity, (2) enhancing nutritional security and combating deficiency diseases, (3) addressing the crisis of antimicrobial resistance, (4) managing hypertension and cardiovascular risk, and (5) exploring supportive and preventive strategies in oncology. Through this framework, we endeavor to translate bench knowledge on indigenous natural products into community-ready knowledge, providing a consolidated evidence base for healthcare practitioners, policymakers, and researchers dedicated to developing holistic, equitable, and effective health solutions for vulnerable populations.

2. MITIGATING ENVIRONMENTAL TOXICITY

Environmental exposure to toxic metals and agrochemicals constitutes a silent, pervasive public health emergency, particularly in communities with mining, industrial, or intensive agricultural activities (Hayes and Hansen, 2017). Metals like manganese (Mn) and cadmium (Cd), along with chlorinated solvents and herbicides such as carbon tetrachloride (CCl_4) and atrazine, are established hepatorenal toxicants. Their mechanisms of injury are complex but converge critically on the induction of oxidative stress the excessive generation of reactive oxygen species (ROS) that overwhelms cellular antioxidant defenses, leading to lipid peroxidation, protein dysfunction, DNA damage, and ultimately, cell death (Williamson *et al.,* 2011; Kim *et al.,* 2014). The liver and kidneys, as primary detoxification and excretion organs, are especially vulnerable. The public health challenge lies not only in preventing exposure a goal often at odds with economic realities but also in identifying safe, accessible agents that can mitigate toxicity in exposed populations. Our research program has extensively investigated the protective potential of indigenous plants against such insults, providing a biochemical rationale for their use as dietary or adjunctive protective agents.

Manganese (Mn) Overexposure and Hepatic Defense

Manganese is an essential trace element, but overexposure, often occupational (e.g., welding, mining), leads to its accumulation in the liver and brain, causing manganism and hepatic dysfunction (Aschner *et al.,* 2009). Our experimental model using manganese chloride ($MnCl_2$) in rats confirmed significant hepatotoxicity, marked by elevated oxidative stress and compromised liver function (Yusuf *etal.,* 2023). In this model, co-treatment with fractions from *Azanza garckeana*, a plant used in traditional medicine, demonstrated a remarkable capacity to restore hepatic redox balance. The treatment significantly ameliorated Mn-induced elevations in markers of lipid peroxidation and nitric oxide, while concurrently boosting the activity of endogenous antioxidants like glutathione (GSH), superoxide dismutase (SOD), and glutathione peroxidase (GPx) (Yusuf *et al.,* 2023). This protective profile suggests that *A. garckeana* constituents, likely rich in phenolic compounds, act as direct free radical scavengers and may also enhance the synthesis of endogenous antioxidant molecules. From a public health perspective, this finding points to the potential of specific dietary components to bolster physiological resilience in individuals with unavoidable environmental or occupational Mn exposure.

Carbon Tetrachloride (CCl_4) and the Protective Role of Curcuminoids

CCl_4 is a classic hepatotoxin used experimentally to model chemical-induced liver cirrhosis; its metabolism generates highly reactive trichloromethyl radicals that initiate a cascade of oxidative damage and inflammation (Poli, 1993). In a study evaluating natural antidotes, curcuminoid isolates from turmeric (*Curcuma longa*) rhizome were investigated (Jonathan *et al.,* 2020). Administration of curcuminoids to CCl_4-intoxicated rats resulted in a significant reversal of hepatic damage. Biochemically, this was evidenced by the restoration of serum transaminase levels (indicative of improved hepatocyte membrane integrity) and a pronounced reduction in hepatic oxidative stress markers (Jonathan *et al.,* 2020). The observed effects align with the known pharmacodynamics of curcumin, which includes potent free radical quenching, inhibition of the pro-inflammatory NF-κB pathway, and upregulation of cytoprotective enzymes (Menon and Sudheer, 2007). This work translates the well-known bioactivity of curcumin into a specific context of acute chemical toxicity, suggesting its value not just as a general dietary antioxidant, but as a potential protective agent against acute hepatotoxic incidents from industrial or environmental solvents.

Atrazine Herbicide Toxicity and Synergistic Plant-Based Intervention

Atrazine, a widely used herbicide, is a concerning environmental pollutant linked to endocrine disruption and organ toxicity (Hayes and Hansen, 2017). Investigating natural ameliorative strategies, we evaluated the combined effects of date syrup and green tea against atrazine-induced hepatic and reproductive toxicity in rats (Adewuyi *et al.,* 2025a). The co-administration of

these two common food-based substances offered significant protection, normalizing atrazine-induced alterations in liver enzymes, oxidative stress markers, and key reproductive hormones. The synergy likely arises from their complementary phytochemical profiles: date syrup is rich in phenolic acids and fructose, while green tea provides catechins like epigallocatechin gallate (EGCG) (Williamson *et al.*, 2011; Kim *et al.*, 2014). This study underscores a practical public health concept: the protective effect against a complex toxicant may not rely on a single purified compound but can be achieved through the synergistic matrix of whole-food interventions. Promoting the dietary inclusion of such functional foods could be a feasible, community-based strategy to mitigate low-level, chronic agrochemical exposure in agricultural communities.

Cadmium (Cd) Toxicity and Multi-Organ Protection with B. ferruginea

Cadmium is a notorious toxic heavy metal with a long biological half-life, causing cumulative damage to the kidneys, liver, and reproductive system (Bernard, 2008). In a comprehensive assessment, extracts of *B. ferruginea* were tested in a cadmium chloride ($CdCl_2$)-induced multi-organ toxicity model in rats (Adewuyi *et al.*, 2025b). The results were striking, showing that *B. ferruginea* treatment attenuated Cd-induced oxidative stress and inflammation in the liver and kidneys, normalized deranged reproductive hormone levels, and improved hematological parameters. The broad-spectrum efficacy suggests that the plant extract contains bioactive principles capable of chelating cadmium or neutralizing its toxic radicals, while also modulating inflammatory pathways and supporting hematopoietic function. For populations in areas with cadmium contamination from mining, electronic waste, or contaminated fertilizers the identification of locally available plants with such multi-organ protective effects is of direct translational relevance. It provides a scientific basis for exploring standardized extracts as potential supportive treatments alongside efforts to reduce exposure.

Synthesis and Public Health Translation

Collectively, these studies (Yusuf *et al.*, 2023; Jonathan *et al.*, 2020; Adewuyi *et al.*, 2025a; Adewuyi *et al.*, 2025b) provide robust preclinical evidence that selected medicinal plants and their constituents can disrupt the key pathological mechanism oxidative stress underpinning toxicity from diverse environmental agents. The public health implication is profound. Instead of viewing toxic exposure as an inevitability with only costly medical management for resultant diseases, these findings support a paradigm of biochemical resilience. This concept involves using known, safe, plant-based compounds to bolster the body's intrinsic defense systems proactively. The next critical steps on the translational pathway involve: (1) identifying and standardizing the most active fractions from these plants, (2) conducting rigorous pharmacokinetic and safety studies in humans, and (3) designing feasible delivery methods such as dietary supplements, functional food fortification, or herbal formulations for at-risk communities. This body of work thus moves the narrative from documenting toxicity to proposing nature-based, accessible solutions for environmental health protection.

3. NUTRITIONAL BIOCHEMISTRY AND FOOD SECURITY

Malnutrition presents a dual public health challenge: the persistent burden of undernutrition and micronutrient deficiencies (hidden hunger) and the escalating epidemic of overnutrition leading to obesity and metabolic syndrome (Black *et al.*, 2013). Both extremes are potent risk factors for non-communicable diseases (NCDs) such as anemia, diabetes, cardiovascular disease, and cancer. In resource-limited settings, where access to diversified diets and pharmaceutical supplements is constrained, locally available functional foods offer a sustainable avenue for improving nutritional status and modulating disease risk. Our research has investigated the biochemical and therapeutic properties of several indigenous food plants, translating their traditional uses into evidence-based insights for public health nutrition strategies.

Addressing Nutritional Anemia with Carica papaya

Iron-deficiency anemia remains one of the world's most prevalent micronutrient disorders, impairing cognitive development, reducing work capacity, and increasing maternal mortality (Black *et al.*, 2013). While iron supplementation is standard, bioavailability and gastrointestinal side effects can limit its effectiveness. Our preclinical study explored the anti-anemic potential of alkaloid and flavonoid constituents from unripe *Carica papaya* in an aluminum chloride-induced anemia model in rats (Adewuyi *et al.*, 2024). The results demonstrated that papaya constituents significantly improved hematological parameters, including hemoglobin, red blood cell count, and packed cell volume. Mechanistically, the recovery was associated with enhanced antioxidant status and reduced markers of hemolysis and oxidative damage to erythrocytes. This suggests that C. papaya does not merely provide bioavailable iron but may protect existing red blood cells from oxidative destruction and support the bone marrow microenvironment for erythropoiesis. From a public health perspective, promoting the consumption of papaya a widely cultivated and accepted fruit could serve as a complementary, food-based strategy to combat anemia, especially in regions where it is endemic.

Cancer Chemoprevention with Dietary Leafy Vegetables: The Case of Telfairia occidentalis

Cancer prevention through dietary modification is a cornerstone of public health oncology (World Cancer Research Fund / American Institute for Cancer Research, 2018). *Telfairia occidentalis* (fluted pumpkin) leaves are a widely consumed vegetable in West Africa. Our investigation into its chemoprotective potential used a 7,12-dimethylbenz[a]anthracene (DMBA)-induced breast cancer model in rats (Adewuyi *et al.*, 2025c). Administration of a methanol leaf extract of T. occidentalis alongside the carcinogen significantly attenuated the development of mammary tumors. Biochemically, the extract treatment mitigated DMBA-induced oxidative stress in breast tissue, preserved hepatic function (often compromised during carcinogen metabolism), and prevented the associated hematological dyscrasias. The observed chemopreventive effect is likely attributable to the rich repertoire of antioxidants, vitamins, and potential phytoestrogens in the leaves, which may modulate carcinogen activation, scavenge reactive intermediates, and inhibit proliferative signaling pathways. This work provides a

scientific rationale for epidemiological studies investigating the association between high intake of traditional leafy greens like *T. occidentalis* and lower cancer incidence, and for promoting their consumption as part of cancer-preventive diets.

Nutraceutical Profiling of Underutilized Food Crops: *Mucuna pruriens* and *Solanum aethiopicum*

Unlocking the nutritional potential of underutilized crops is key to diversifying diets and improving food security. Our comprehensive phytochemical and nutritional profiling of velvet bean *(Mucuna pruriens)* and African eggplant (*Solanum aethiopicum*) revealed their substantial value as functional foods (Adewuyi, 2025). *M. pruriens* was found to be a rich source of protein, essential amino acids, and L-DOPA, a compound with implications for neurological and metabolic health. *S. aethiopicum* was laden with antioxidants, vitamins (notably vitamin C and beta-carotene), and minerals. Both plants contained significant levels of phenolic compounds linked to antioxidant and anti-inflammatory activities. This analytical work moves these crops from being merely traditional staples to being recognized as nutraceuticals foods with defined health benefits beyond basic nutrition. Public health interventions could include agricultural extension programs to promote their cultivation and culinary education to integrate them into daily meals, thereby enhancing the nutritional density of local diets cost-effectively.

Gastrointestinal Health and Safety of Food Medicinals: Albizia lebbeck and Curcuma longa

The gastrointestinal (GI) tract is central to nutrient absorption and overall health. Many traditional food-medicines are used to aid digestion. A sub-chronic toxicity and pharmacological study evaluated the effects of extracts from *Albizia lebbeck* (Indian siris) and *Curcuma longa* (turmeric) on GI motility, hematology, and organ safety in rats (Fagbohun *et al.*, 2025b). The findings indicated that these extracts enhanced GI motility without inducing adverse effects on major organs or blood parameters at tested doses. Improved GI motility can alleviate constipation, promote better nutrient absorption, and support gut health. The safety profile is particularly crucial for public health translation, as it suggests that these commonly used botanicals can be incorporated into diets or as mild digestive aids without significant risk of toxicity. This supports their safe use within community-based approaches to manage common digestive complaints and improve overall nutritional well-being.

Synthesis and Public Health Translation

This cluster of studies (Adewuyi *et al.*, 2024; Adewuyi *et al.*, 2025c; Adewuyi, 2025; Fagbohun *et al.*, 2025b) illuminates a clear path from local food biodiversity to targeted public health outcomes. The evidence suggests that:

1. Specific foods can act as natural supplements to address widespread deficiencies like anemia.
2. Daily dietary components can carry chemopreventive properties, potentially lowering the risk of NCDs like cancer at a population level.
3. Underutilized crops are reservoirs of essential nutrients and bioactives, offering solutions for dietary diversification and hidden hunger.
4. Common culinary herbs and vegetables support foundational health (e.g., digestion) with a high safety margin.

The translational imperative is to integrate this biochemical evidence into nutrition-sensitive agriculture and dietary guideline development. Community health workers can be trained to promote these specific functional foods for targeted health goals. Furthermore, this research provides a template for validating other locally available plants, building a region-specific evidence base for food-based interventions that are culturally acceptable, economically viable, and scientifically grounded. This moves public health nutrition beyond generic advice to eat more fruits and vegetables towards the strategic promotion of specific, locally relevant superfoods with demonstrated biochemical benefits.

4. ANTIMICROBIAL RESISTANCE AND GREEN NANOTECHNOLOGY

The relentless rise of antimicrobial resistance (AMR) is a slow-motion global crisis, threatening to undo a century of medical progress (O'Neill, 2016). As conventional antibiotics lose efficacy, the pipeline for new synthetic drugs is dwindling. This dire situation has catalyzed a paradigm shift towards exploring alternative sources, with natural products and innovative delivery systems at the forefront (Cowan, 1999). Concurrently, nanotechnology has emerged as a revolutionary tool, offering novel ways to enhance the efficacy and delivery of therapeutic agents. Our research program has engaged with both frontiers, investigating the intrinsic antimicrobial properties of medicinal plants and pioneering the green synthesis of metallic nanoparticles using plant extracts. This dual approach represents a convergence of traditional ethnopharmacology and cutting-edge materials science, aimed at developing sustainable solutions for infectious disease control.

Direct Antimicrobial Action of Plant Phenolics and Flavonoids

The search for new antimicrobial scaffolds often begins with plant secondary metabolites, which have co-evolved as chemical defenses against pathogens. Our investigations into *Chromolaena odorata* and *Maytenus heterophylla* validated their traditional use in wound care and infection (Fagbohun *et al.*, 2025c; Umar *et al.*, 2019). Phytochemical characterization of *C. odorata* fractions revealed rich concentrations of phenolic acids and flavonoids, which correlated strongly with their significant in vitro antibacterial activity against a panel of clinically relevant pathogens, including *Staphylococcus aureus* and *Escherichia coli* (Fagbohun *et al.*, 2025c). Similarly, naturally occurring flavonoids isolated from *M. heterophylla* demonstrated potent in situ antioxidant and antimicrobial activities, with the added confirmation of safety in a rodent model (Umar *et al.*, 2019). The mechanism of action for such polyphenols is multifaceted, including disruption of microbial cell membranes, inhibition of virulence factor production, and interference with essential enzymatic pathways (Cowan, 1999). These studies provide a scientific basis for the standardized development of topical antiseptics or herbal formulations from these plants, offering

accessible first-line options for managing skin and soft tissue infections in community settings, potentially reducing the inappropriate use of systemic antibiotics.

Green Nanotechnology: Biosynthesized Silver and Zinc Oxide Nanoparticles

Moving beyond crude extracts, nanotechnology offers a powerful way to enhance the bioavailability and potency of plant-derived actives. The green synthesis of nanoparticles using plant extracts is an eco-friendly alternative to chemical methods, where the phytochemicals act as both reducing and capping agents, imparting additional biological functionality (Król *et al.*, 2019). We successfully applied this approach using leaf extracts of *Senna occidentalis* to synthesize silver nanoparticles (AgNPs) and zinc oxide nanoparticles (ZnO NPs) (Unuata *et al.*, 2025a; Unuata *et al.*, 2025b). Comprehensive characterization confirmed the formation of stable, nanoscale particles. Importantly, these biosynthesized nanoparticles exhibited markedly enhanced antimicrobial efficacy compared to the plant extract alone. The AgNPs showed potent activity against a range of bacteria, while the ZnO NPs displayed significant antibacterial and antifungal properties. The antimicrobial mechanisms of metal nanoparticles include the generation of reactive oxygen species, release of toxic metal ions, and direct physical damage to microbial cell walls (Wang *et al.*, 2017). The use of *S. occidentalis*, a plant with known medicinal properties, likely results in nanoparticles with a synergistic phytochemical corona, potentially broadening their spectrum of action and reducing toxicity.

Nano-hematinics: A Systems Approach to Blood Disorders

Extending the nanomedicine concept beyond infectious disease, our work has also explored nano-hematinics plant-based nanomedicines for blood disorders (Adewuyi *et al.*, 2025d). This innovative review and conceptual analysis highlights the potential of nano-encapsulation to improve the delivery and targeting of iron, vitamin B12, folic acid, and other hematinic agents derived from plants. For instance, the poor solubility and bioavailability of many plant-based iron compounds limit their therapeutic utility for treating anemia. Nano-formulations can protect these sensitive molecules, enhance their absorption in the gut, and allow for targeted release. This approach represents a sophisticated advancement from simply consuming iron-rich plants to engineering their active principles into highly efficient therapeutic delivery systems. It bridges the gap between nutritional biochemistry for anemia and advanced drug delivery technology.

Synthesis and Public Health Translation

The collective evidence from these studies (Fagbohun *et al.*, 2025c; Umar *et al.*, 2019; Unuata *et al.*, 2025a; Unuata *et al.*, 2025b; Adewuyi *et al.*, 2025d) maps a translational trajectory from traditional herbal remedies to next-generation antimicrobial and therapeutic strategies. The public health implications in the context of AMR are substantial:

1. Development of Local, Sustainable Antiseptics: Standardized formulations based on *C. odorata* or *M. heterophylla* could be developed into affordable, widely available topical antiseptics for community health posts and home care, reducing reliance on antibiotic creams.
2. Innovation in Disinfection and Wound Care: Biosynthesized AgNPs and ZnO NPs have potential applications beyond internal use. They could be incorporated into wound dressings, surface disinfectants, or water purification systems, offering novel, potent tools for infection control in healthcare and community settings.
3. A Model for Next-Generation Nutraceuticals: The nano-hematinics concept provides a blueprint for how nanotechnology can revolutionize the delivery of nutritional interventions, making them more effective for treating conditions like anemia---a prime example of interdisciplinary innovation for public health.

The path forward requires interdisciplinary collaboration among ethnobotanists, biochemists, nanotechnologists, and clinical researchers. Key steps include scaling up the green synthesis process, conducting detailed toxicological profiling of the novel nanoparticles in vivo, and designing appropriate delivery systems for clinical testing. By validating and advancing these plant-nanotech hybrids, we can contribute to a diversified arsenal against AMR and other health challenges, leveraging indigenous biodiversity through a modern scientific lens. This work exemplifies how biochemical research can evolve into disruptive public health technology.

5. CARDIOVASCULAR RISK MANAGEMENT

Cardiovascular diseases (CVDs), with hypertension as a leading modifiable risk factor, constitute the single greatest cause of mortality worldwide, and their burden is rising most sharply in low- and middle-income countries (World Health Organization, 2023). The management of hypertension in these settings is hampered by challenges of lifelong drug adherence, cost, side effects, and often, a lack of symptomatic awareness. This creates a critical public health niche for safe, effective, and culturally embedded complementary approaches. Our research has engaged with this challenge on two complementary fronts: firstly, by investigating the biochemical and hemodynamic effects of traditional antihypertensive plants in preclinical models, and secondly, by examining relevant biochemical markers in both experimental and clinical hypertensive contexts. This work aims to build an evidence bridge from ethnomedical knowledge to potential adjunctive strategies for community-based CVD risk reduction.

Preclinical Validation of Antihypertensive Phytotherapy: Euphorbia hirta and Leptadenia hastata

A cornerstone of our work in this area has been the systematic evaluation of two plants with traditional reputations for managing high blood pressure. In adrenaline-induced hypertensive rat models a simulation of sympathetic nervous system overdrive both *Euphorbia hirta* and *Leptadenia hastata* extracts demonstrated significant dose-dependent antihypertensive activity (Fagbohun *et al.*, 2025a; Adewuyi *et al.*, 2020). *L. hastata*, in particular, was shown to not only lower elevated blood

pressure but also to normalize associated hematological alterations, such as elevated red blood cell counts and hematocrit, which can contribute to increased blood viscosity (Adewuyi *et al.,* 2020). The observed effects are likely mediated through a combination of mechanisms common to many cardiovascular-active phytochemicals: vasodilation via nitric oxide pathways, calcium channel blockade, diuretic action, and attenuation of sympathetic tone (Tabassum and Ahmad, 2011). These preclinical findings provide a robust pharmacological justification for the traditional use of these plants and highlight them as prime candidates for further standardization and clinical investigation.

Biochemical Markers in Hypertension: From Clinical Observation to Experimental Models

Understanding the biochemical milieu of hypertension is key to both risk stratification and monitoring therapeutic efficacy. We extended our inquiry from the laboratory to a clinical setting with an assessment of biochemical markers among hypertensive patients at Nyanya General Hospital, Nigeria (Adewuyi *et al.,* 2025e). This study provided a real-world snapshot of the metabolic dysregulation accompanying hypertension in the local population, including potential alterations in renal function, electrolytes, and lipid profiles. To complement this clinical observation and allow for mechanistic dissection, we employed an experimental salt-loading Wistar rat model of hypertension (Adewuyi *et al.,* 2025f). This model allowed us to study the modulatory effects of selected phytochemicals on a well-defined hypertensive pathophysiology driven by volume expansion. The interplay between clinical data and controlled experimental models strengthens the translational relevance of the findings, ensuring that preclinical studies address biomarkers and pathways that are pertinent to the human disease presentation in the target population.

Cardioprotection Beyond Blood Pressure: Gongronema latifolium and Chemotherapy-Associated Toxicity

Cardiovascular risk management also involves protecting the heart and vasculature from iatrogenic damage. The anticancer drug tamoxifen, while lifesaving, is associated with an increased risk of thromboembolic events and metabolic syndrome. Our investigation into the effects of *Gongronema latifolium* extracts on tamoxifen-induced toxicity in rats revealed significant protective effects (Ogar *et al.,* 2025). Treatment with the extract mitigated tamoxifen-induced oxidative stress and inflammation in cardiac and hepatic tissues. While not a direct antihypertensive, this work underscores the broader concept of cardiometabolic protection offered by phytochemicals. Plants like *G. latifolium*, rich in antioxidants and anti-inflammatory compounds, may play a supportive role in managing the cardiovascular side effects of essential chronic medications, an important aspect of comprehensive care for patients with comorbidities like cancer and hypertension.

Synthesis and Public Health Translation

The collective evidence from these hypertension-focused studies (Fagbohun *et al.,* 2025a; Adewuyi *et al.,* 2020; Adewuyi *et al.,* 2025e; Adewuyi et al., 2025f; Ogar et al., 2025) outlines a cohesive strategy for integrating herbal medicine into public health approaches for CVD prevention:

1. Identification and Validation of Lead Plants: *E. hirta* and *L. hastata* emerge from traditional practice with strong preclinical validation, making them priority candidates for developing standardized herbal supplements or teas for mild hypertension or as adjuncts to conventional therapy.
2. Biomarker-Guided Intervention: The work on biochemical markers provides a framework for monitoring the efficacy of such interventions not just by blood pressure measurement, but also through accessible serum biomarkers of oxidative stress, inflammation, and organ function, allowing for more personalized management.
3. Holistic Risk Reduction: The research on *G. latifolium* expands the scope from merely lowering blood pressure to protecting the cardiovascular system from other insults, advocating for a diet rich in protective phytochemicals as a foundational element of cardiovascular health.

The public health translation pathway involves several critical steps: (1) Conducting rigorous randomized controlled trials (RCTs) with standardized extracts of the most promising plants (*E. hirta, L. hastata*) in human hypertensive populations; (2) Developing clear dosage guidelines and safety profiles for long-term use; (3) Training community health workers to identify hypertension and counsel on the appropriate use of evidence-based herbal adjuncts alongside lifestyle modification. By scientifically validating and responsibly integrating these local resources, public health systems can offer a more holistic, accessible, and potentially more acceptable strategy for controlling the hypertension epidemic, particularly in primary care and community health settings where resources are scarce.

6. CANCER THERAPEUTICS AND SYSTEMS BIOLOGY

Cancer remains a leading cause of death globally, with its burden disproportionately affecting regions where healthcare systems are least equipped to handle the complexities of diagnosis, treatment, and palliative care (Global Burden of Disease Cancer Collaboration, 2022). The high cost, toxicity, and limited access to conventional oncology therapies in low-resource settings necessitate the exploration of complementary and supportive strategies. Within this public health challenge, medicinal plants offer a multi-faceted promise: as sources of chemopreventive agents, as adjuvants to mitigate therapy-related side effects, and as potential leads for novel therapeutic compounds. Our research in this domain spans from systematic reviews of evolving cancer strategies to preclinical investigations of specific plants, applying a systems perspective that acknowledges the interconnectedness of cancer with metabolic and inflammatory diseases.

Systematic Analysis of Evolving Therapeutic Landscapes

To ground specific experimental work in the broader context of oncological progress, we conducted systematic reviews focusing on prostate cancer and the role of multifunctional natural products (Adewuyi *et al.,* 2025g; Adeleye *et al.,* 2025). The

review on prostate cancer therapy evolution synthesized recent breakthroughs, from advanced hormonal agents to immunotherapies and emerging targeted strategies (Adewuyi *et al.*, 2025g). This work is crucial for public health as it provides a contextual map, highlighting where affordable, accessible interventions like supportive phytotherapy could fill gaps, such as in managing side effects of androgen deprivation therapy or in low-grade disease monitoring. The second review framed natural products not as mere "alternative" treatments but as multifunctional agents within a systems biology perspective, particularly for intersecting diseases like cancer and cardiovascular disorders (Adeleye *et al.*, 2025). This perspective is vital for public health in aging populations where multimorbidity is common, suggesting that certain phytochemicals (e.g., curcumin, resveratrol) might simultaneously target shared pathological pathways like chronic inflammation and oxidative stress, offering efficient, holistic intervention points.

Chemoprevention and Adjunctive Therapy with Dietary Plants

Building on the chemopreventive potential of *Telfairia occidentalis* (Adewuyi *et al.*, 2025c), our exploration extends to other plants used traditionally. *Vernonia amygdalina* (bitter leaf), widely consumed as a vegetable, was investigated in an alloxan-induced diabetic rat model (Ogar *et al.*, 2025). The study demonstrated its potent antihyperglycemic, antihyperlipidemic, hepatoprotective, and antioxidant effects. Given the well-established link between diabetes, chronic inflammation, and increased risk of several cancers, the systemic anti-inflammatory and metabolic-normalizing properties of *V. amygdalina* position it as a strong candidate for dietary cancer prevention (Giovannucci *et al.*, 2010). By improving metabolic health and reducing systemic oxidative stress, regular consumption of such plants may lower the foundational risk for carcinogenesis. This aligns with public health strategies promoting "food as medicine" for primary NCD prevention, where a single dietary component can address multiple risk factors.

Managing Comorbidity and Therapy-Associated Toxicity

The cancer journey is often complicated by comorbidities and the toxic effects of treatment. Our work on *Gongronema latifolium's* protection against tamoxifen toxicity, (Ogar *et al.*, 2025), is a direct example of phytotherapy's role in supportive oncology. By mitigating drug-induced oxidative stress and inflammation, such adjuvants could improve a patient's tolerance to essential chemotherapy, potentially allowing for treatment completion and improving quality of life a significant concern in oncology public health. Similarly, the exploration of *Zingiber officinale* (ginger) juice extract against cisplatin-induced toxicity revealed its protective effects on oxidative stress, hematological parameters, and reproductive hormones (Adewuyi *et al.*, 2025h). Cisplatin is a cornerstone chemotherapeutic with severe nephrotoxic and myelosuppressive side effects. Identifying safe, accessible agents like ginger that can ameliorate these toxicities without interfering with chemotherapeutic efficacy is of immense practical value. It could help maintain treatment regimens in settings where supportive care options like expensive growth factors or intensive hydration protocols are limited.

Synthesis and Public Health Translation

The collective insights from this body of work (Adewuyi *et al.*, 2025c; Adewuyi *et al.*, 2025g; Adeleye *et al.*, 2025; Ogar *et al.*, 2025; Adewuyi et al., 2025h) sketch a multi-tiered public health strategy for integrating phytomedicine into cancer control:

1. Primary Prevention (Population Level): Promote the dietary incorporation of chemopreventive plants like *T. occidentalis* and *V. amygdalina* through nutrition education. This is a low-cost, scalable approach to reduce population-level cancer risk factors linked to diet and inflammation.
2. Supportive Care (Health System Level): Develop and validate standardized herbal adjuvants, such as *G. latifolium* or *Z. officinale* extracts, to manage the side effects of conventional chemotherapy and radiotherapy. This can improve treatment adherence, outcomes, and quality of life, making cancer care more humane and sustainable in resource-constrained settings.
3. Research and Development (Innovation Level): Use the systematic review and multifunctional agent framework to prioritize local plants for further investigation. This involves isolating compounds, understanding their mechanisms within cancer signaling networks, and exploring synergies with existing treatments.

The translational pathway requires strengthening collaboration between oncologists, traditional medicine practitioners, and biomedical researchers. Key steps include conducting pharmacokinetic studies to ensure no harmful interactions with conventional drugs, and implementing well-designed clinical trials to evaluate the efficacy of herbal adjuvants for specific chemotherapy side effects. By framing medicinal plants not as replacements for oncology care but as integral components of a supportive, preventive, and holistic public health strategy for cancer, this work contributes to more resilient and accessible cancer control ecosystems.

7. TRANSLATIONAL INTEGRATION OF BIOCHEMICAL EVIDENCE INTO PUBLIC HEALTH ACTION

7.1 Cross-Cutting Scientific and Public Health Themes

Several unifying themes bridge the five thematic areas explored:

· ***The Centrality of Redox Balance:*** From the hepatorenal protection offered by *Azanza garckeana* and curcuminoids against chemical toxicants (Yusuf *et al.*, 2023; Jonathan *et al.*, 2020) to the chemopreventive action of *Telfairia occidentalis* (Adewuyi *et al.*, 2025c) and the cardiovascular benefits of antihypertensive plants (Fagbohun *et al.*, 2025a; Adewuyi *et al.*, 2020), the restoration of glutathione levels and antioxidant enzyme activities is a consistent biochemical endpoint. This underscores

oxidative stress as a common, modifiable final pathway for diverse insults, making dietary antioxidants a foundational public health strategy for resilience.

· ***Synergy and the Whole-Plant Matrix:*** The research on date syrup and green tea against atrazine (Adewuyi *et al.*, 2025a) and the multifunctional effects of plants like *Vernonia amygdalina* (Ogar *et al.*, 2025) highlight that therapeutic benefits often arise from the synergistic interaction of multiple compounds within a plant matrix. This supports a public health approach favoring the promotion of whole foods and standardized whole-plant extracts over isolated, single-component supplements, aligning with cultural practices and likely improving safety profiles.

· ***Dual Utility in Infectious and Chronic Disease:*** Plants like *M. heterophylla* (Umar *et al.*, 2019) and biosynthesized nanoparticles (Unuata *et al.*, 2025a; Unuata *et al.*, 2025b) demonstrate direct antimicrobial activity, addressing the AMR crisis. Simultaneously, their inherent antioxidant properties link to NCD prevention. This dual functionality is a major public health asset, suggesting that interventions designed for one purpose (e.g., infection control) may confer secondary benefits (e.g., reduced inflammation) against chronic conditions.

7.2 Public Health Implications: Policy, Practice, and Research

The translation of this biochemical evidence into tangible health gains requires action across three domains:

· ***Policy:*** National health and agriculture policies should recognize specific, validated functional foods (e.g., *Carica papaya* for anemia, *Telfairia occidentalis* as a chemopreventive vegetable) as strategic resources. This can inform nutrition-sensitive agricultural programs to promote their cultivation and dietary guidelines that go beyond generic advice to recommend these evidence-based local superfoods for specific health goals. Regulatory frameworks for herbal medicine products need strengthening to ensure the quality, safety, and standardization of extracts like those from *Euphorbia hirta* or *Gongronema latifolium* for adjuvant use.

· ***Practice:*** At the primary care and community health level, this knowledge can be operationalized. Community health workers can be trained to educate populations on using *C. papaya* to combat anemia, or on preparing simple teas from L. hastata for mild blood pressure management alongside lifestyle counseling. Clinical practice can begin to incorporate validated herbal adjuvants, like ginger for cisplatin-induced nausea or *G. latifolium* extracts for managing metabolic side effects of certain drugs, as part of supportive care protocols where resources allow.

· ***Research:*** The current work, largely preclinical, defines a clear research agenda. Priority must shift to human clinical trials Randomized Controlled Trials (RCTs) for antihypertensive herbs, dose-finding studies for chemopreventive agents, and intervention studies on functional foods for anemia. Phytochemical standardization and safety pharmacology (including drug-herb interaction studies) are non-negotiable next steps. Furthermore, implementation research is needed to understand the barriers and facilitators to integrating these evidence-based plants into existing health and food systems.

7.3 Limitations of the Reviewed Work

A candid acknowledgment of limitations strengthens the translational argument. The primary limitation of the synthesized work is its preclinical focus. While rat models provide crucial mechanistic insights, they do not directly predict human efficacy, dosage, or long-term safety. Secondly, many studies used crude extracts or fractions, necessitating further work to identify the most active compounds and standardize preparations. Finally, the context of multimorbidity and polypharmacy, common in real-world public health, was not fully captured in the individual animal studies. The potential for interactions between multiple plant-based interventions or with conventional pharmaceuticals requires careful future study.
Based on this synthesis, we propose a structured, five-phase roadmap to guide future efforts:

1. ***Prioritization & Standardization:*** Identify the 3-5 most promising leads from each thematic area (e.g., *A. garckeana* for toxicity, *C. papaya* for anemia, *E. hirta* for hypertension, *C. odorata* for antimicrobials, *T. occidentalis* for chemoprevention). Develop standardized, chemically characterized extracts for each.
2. ***Safety & Pharmacokinetic Profiling:*** Conduct rigorous sub-chronic and chronic toxicity studies in relevant animal models. Establish basic pharmacokinetic profiles (absorption, distribution, metabolism, excretion) for key compounds.
3. ***Proof-of-Concept & Efficacy Trials:*** Execute phased clinical trials, starting with small-scale pilot studies for safety in humans (Phase I/II), followed by efficacy RCTs for specific indications (e.g., *L. hastata* extract vs. placebo for stage I hypertension).
4. ***Delivery System & Implementation Design:*** Develop appropriate, acceptable, and stable delivery systems (e.g., capsules, fortified food products, topical ointments). Design implementation packages for community health workers, including training modules and monitoring tools.
5. ***Integration & Scale-Up:*** Work with ministries of health and agriculture to integrate successful interventions into national programs (e.g., antenatal care for anemia, primary care guidelines for hypertension, agricultural extension for functional food crops). Monitor population-level impact through health information systems.

The journey from bench to community is complex but necessary. This review has demonstrated that the biochemical investigation of indigenous flora is not an academic exercise in isolation, but the first critical step in building a repository of locally relevant, scientifically-grounded solutions for pervasive public health challenges. By viewing medicinal plants and

functional foods through the integrated lenses of environmental health, nutrition security, infectious disease control, and chronic disease management, we can move towards a more resilient, equitable, and culturally resonant model of public health. The evidence synthesized here provides a robust platform for action. The next steps require interdisciplinary courage, investment, and a steadfast commitment to translating this knowledge into health and well-being for the communities who are the custodians of this invaluable biodiversity.

8. CONCLUSION

This narrative review has synthesized a multi-faceted research program to construct a clear, evidence-based argument: indigenous medicinal plants and functional foods hold immense, untapped potential as accessible public health resources. By demonstrating their efficacy against environmental hepatotoxicants, nutritional deficiencies, antimicrobial pathogens, cardiovascular risk factors, and cancer-related toxicity, we have moved beyond documenting isolated biological activities. Instead, we have woven these findings into a coherent narrative that positions phytochemicals as vital tools for building biochemical resilience at the population level. The cross-cutting mechanisms of antioxidant defense, anti-inflammatory action, and metabolic regulation provide a unified scientific rationale for their use. The imperative now is translation. Bridging the gap between this robust preclinical evidence and community health impact requires a concerted, interdisciplinary effort focused on clinical validation, safety assurance, and the thoughtful integration of standardized, evidence-based plant interventions into primary healthcare and food systems. Embracing this bench to community pathway offers a pragmatic, culturally resonant strategy to mitigate the interconnected burdens of disease and move towards more equitable and sustainable health for all.

9. DECLARATIONS

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.

Funding

The research synthesized in this review received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The individual studies were supported by institutional resources.

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.

Acknowledgements

The authors gratefully acknowledge the contributions of Dr Hassan Abdulsalam Adewuyi, researchers, and collaborators involved in the primary research studies that formed the basis of this synthesis. We also thank the Department of Biochemistry, Federal University of Technology, Minna, for providing an enabling environment for this research program.

REFERENCES

Adeleye, A. E., Owolabi, M. S., Abdulkabir, A. O., Adewuyi, H. A. (2025). Multifunctional Natural Products in Disease Modulation: A Systems Perspective on Cancer and Cardiovascular Therapies. AROC Pharm Biotechnol, 5(1), 01-08.

Adewuyi, H. A. (2025). Nutritional and Phytochemical Profiling of Velvet bean (*Mucuna pruriens*) and African Spinach (*Solanum aethiopicum*): Unlocking Their Potential for Human Health. Egypt J Nutr, 40(2), 1–13.

Adewuyi, H. A., Kabiru, A. Y., Muhammad, H. L., et al. (2024). Pre-clinical protective potentials of Carica Papaya Constituents in Experimentally Induced Anemia. Am J Transl Res, 16(7), 3259-3272. https://doi.org/10.62347/ZQDC9694

Adewuyi, H. A., Mohammed, A. U., Jaiyeola, T. O., et al. (2025e). Biochemical Markers and Hypertension Management in Salt-Loading Wistar Rats Model: Modulatory Effects of Selected Phytochemicals [Preprint]. Res Sq. DOI: 10.21203/rs.3.rs-7541074/v1.

Adewuyi, H. A., Mohammed, A. U., Jaiyeola, T. O., Shamsudeen, K. (2025a). Protective effect of date syrup and green tea against Atrazine-induced Hepatic, and Reproductive toxicity in male albino wistar rats [Preprint]. Res Sq. DOI: 10.21203/rs.3.rs-7416536/v1.

Adewuyi, H. A., Muhammad, L. H., Ibrahim, J., et al. (2020). Protective role of Leptadenia hastata on haematological and biochemical alterations in adrenalin induced hypertensive rats. Iran J Toxicol, 14(1), 25-32.

Adewuyi, H. A., Shamsudeen, K. O., Adio, S. W., et al. (2025g). Prostate cancer therapy evolution: A systematic review of recents breakthroughs and emerging strategy [Preprint]. Res Sq. DOI: 10.21203/rs.3.rs-5813271/v1.

Adewuyi, H. A., Shamsudeen, K., Muhammad, F. M., et al. (2025d). Emerging nanotechnology approaches for blood disorders: A comprehensive review of nanohematinics and plant-based nanomedicines [Preprint]. OSF Preprints. DOI: 10.31219/osf.io/gbd8v.

Adewuyi, H. A., Shekari, A., Adio, S. W., et al. (2025b). Ameliorative effects of B. ferruginea extracts on cadmium chloride-induced reproductive hormone imbalance, oxidative stress, hepatorenal damage, hematological disorders and acute toxicity in wistar rats [Preprint]. bioRxiv. DOI: 10.1101/2025.01.12.632595.

Adewuyi, H. A., Ugwu, C. S., Adio, S. W., et al. (2025c). Chemotherapeutic potential of methanol leaf extract of Telfairia occidentalis on oxidative stress, hepatic, hematological, and biochemical alterations in DMBA-induced breast cancer in Wistar rats. Arch Adv Biosci, 16(1), 1-7.

Adewuyi, H. A., Usman, L. A., Abdulkabir, O., et al. (2025h). Protective effect of Zingiber officinale juice extracts against Cisplatin-induced toxicity: Oxidative stress, Biochemical, Hematological and Reproductive hormone changes in wistar rats [Preprint]. bioRxiv. DOI: 10.1101/2025.08.11.669715.

Aschner, M., Erikson, K. M., Hernández, E. H., Tjalkens, R. (2009). Manganese and its role in Parkinson's disease: from transport to neuropathology. Neuromolecular Med, 11(4), 252-266.

Bernard, A. (2008). Cadmium & its adverse effects on human health. Indian J Med Res, 128(4), 557-564.

Beutler, E., Duron, O., Kelly, B. M. (1963). Improved method for the determination of blood glutathione. J Lab Clin Med, 61, 882–888.

Black, R. E., Victora, C. G., Walker, S. P., et al. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet, 382(9890), 427-451.

Chang, Z., Zhang, Z., Wang, C. (2023). Concurrent exposure to higher concentrations of heavy metal mixtures associated with liver function indicators. Sci Total Environ, 857, 160297.

Cowan, M. M. (1999). Plant products as antimicrobial agents. Clin Microbiol Rev, 12(4), 564-582.

Dorman, D. C. (2023). The Role of Oxidative Stress in Manganese Neurotoxicity: A Literature Review Focused on Contributions Made by Professor Michael Aschner. Biomolecules, 13(8), 1176.

Eiserich, J. P., Baldus, S., Brennan, M. L., et al. (2002). Myeloperoxidase, a leukocyte-derived vascular NO oxidase. Science, 296(5577), 2391-2394.

Fagbohun, B. O., Adewuyi, H. A., Adio, S. W., et al. (2025c). Phytochemical analysis, antioxidant, and antibacterial properties of partition fractions of Adansonia digitata and Annona muricata extracts using chloroform, ethyl acetate, ethanol, and aqueous solvent systems. J Biomed Clin Res, 18, 199-213.

Fagbohun, B. O., Adewuyi, H. A., Messiah, A. I., et al. (2025f). Antihypertensive potential of Euphorbia hirta and Leptadenia hastate in adrenalin-induced wistar rats. Pharm Biomed Res, 11(2), 1365.1.

Fagbohun, B. O., Adewuyi, H. A., Musa, M., et al. (2025b). Evaluation of Albizia lebbeck and Curcuma longa Extracts on Gastrointestinal Motility, Safety, and Hematological Parameters: A Sub-Chronic Toxicity and Pharmacological Study. Asia Pac J Med Toxicol, 14(1), 1-6.

Fagbohun, B. O., Ogar, O. E., Messiah, A. I., Adewuyi, H. A., et al. (2025a). Phytotherapeutic approach to hypertension: a randomized control trial of Euphorbia hirta and Leptadenia hastata extracts in adrenaline-induced hypertensive Wistar rats. Pharm Biomed Res, 11(2), 3-10.

Gan, C., Wu, A., Zhang, Y., et al. (2025). Liver diseases: Epidemiology, causes, trends and predictions. Signal Transduct Target Ther, 10(1), 63.

GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet, 392(10159), 1789-1858.

Giovannucci, E., Harlan, D. M., Archer, M. C., et al. (2010). Diabetes and cancer: a consensus report. Diabetes Care, 33(7), 1674-1685.

Global Burden of Disease Cancer Collaboration. (2022). Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019. JAMA Oncol, 8(3), 420-444.

Guevara, I., Iwanejko, J., Dembińska-Kieć, A., et al. (1998). Determination of nitrite/nitrate in human biological material by the simple Griess reaction. Clin Chim Acta, 274(2), 177-188.

Haque, S., Bruce, D., Vardy, J. (2003). Determination of glutathione peroxidase in tissues. Anal Biochem, 315(1), 38-43.

Hayes, T. B., Hansen, M. (2017). From silent spring to silent night: Agrochemicals and the anthropocene. Elementa, 5, 57.

Heinrich, M., Appendino, G., Efferth, T., et al. (2020). Best practice in research -- Overcoming common challenges in phytopharmacological research. J Ethnopharmacol, 246, 112230.

Jaeschke, H., McGill, M. R., Ramachandran, A. (2012). Oxidant stress, mitochondria, and cell death mechanisms in drug-induced liver injury: lessons learned from acetaminophen hepatotoxicity. Drug Metab Rev, 44(1), 88-106.

Jonathan, I., Kabiru, A. Y., Tawakaltu, A. A., Lawal, B., Adewuyi, H. A. (2020). Antioxidant and hepatoprotective potentials of curcuminoid isolates from turmeric (Curcuma longa) rhizome on CCl4-induced hepatic damage in Wistar rats. J Taibah Univ Sci, 14(1), 908-915.

Kakkar, P., Das, B., Viswanathan, P. N. (1984). A modified spectrophotometric assay of superoxide dismutase. Indian J Biochem Biophys, 21(2), 130-132.

Kim, H. S., Quon, M. J., Kim, J. A. (2014). New insights into the mechanisms of polyphenols beyond antioxidant properties; lessons from the green tea polyphenol, epigallocatechin 3-gallate. Redox Biol, 2, 187-195.

Król, A., Railean-Plugaru, V., Pomastowski, P., et al. (2019). Phytochemical investigation of Medicago sativa L. extract and its potential as a safe source for the synthesis of ZnO nanoparticles: the promising effect of malignant cells treatment. Artif Cells Nanomed Biotechnol, 47(1), 1037-1047.

Laxminarayan, R., Duse, A., Wattal, C., et al. (2013). Antibiotic resistance---the need for global solutions. Lancet Infect Dis, 13(12), 1057-1098.

Menon, V. P., Sudheer, A. R. (2007). Antioxidant and anti-inflammatory properties of curcumin. Adv Exp Med Biol, 595, 105-125.

Ogar, O. E., Messiah, A. I., Adewuyi, H. A., et al. (2025). Antihyperglycemic, antihyperlipidemic, hematological, hepatoprotective, antioxidant effect of V. amygdalina on alloxan-induced diabetic rats [Preprint]. Res Sq. DOI: 10.21203/rs.3.rs-5813319/v1.

O'Neill, J. (2016). Tackling drug-resistant infections globally: final report and recommendations. The Review on Antimicrobial Resistance.

Poli, G. (1993). Liver damage due to free radicals. Br Med Bull, 49(3), 604-620.

Ruwizhi, N., Aderibigbe, B. A. (2020). The Efficacy of Selected Medicinal Plants Against Microbial Infections. J Herb Med, 24, 100402.

Santos-Buelga, C., Mateus, N., De Freitas, V. (2023). Phenolic acids: Chemistry and applications. Compr Rev Food Sci Food Saf, 22(1), 1032-1057.

Sova, M., Saso, L. (2020). Antioxidant and pro-oxidant activities of polyphenols: Theoretical and practical aspects. Oxid Med Cell Longev, 2020, 1-20.

Sung, H., Ferlay, J., Siegel, R. L., et al. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin, 71(3), 209-249.

Tabassum, N., Ahmad, F. (2011). Role of natural herbs in the treatment of hypertension. Pharmacogn Rev, 5(9), 30-40.

Thefeld, W., Hagedorn, E., Klener, E. (1974). ALT and AST determination in serum. Med Klinik, 69(6), 263-269.

Umar, S. I., Abdullahi, A., Adewuyi, H. A., Yusuf, M. A., Lawal, A. B. (2019). In situ antioxidant and antimicrobial activities of naturally occurring flavonoids from Maytenus heterophylla (Eckl&Zeyh.) N. Robson and its safety in wister rats. Iran J Toxicol, 13(4), 9-44.

Unuata, O. N., Shittu, O. K., Tijani, J. O., Adewuyi, H. A. (2025a). Biosynthesis of Zinc Oxide Nanoparticles by Sol-gel Approach: Enhancing Anticorrosion Efficacy. Pharm Biomed Res, 11(1), 61-68.

Unuata, O. N., Shittu, O. K., Tijani, J. O., Adewuyi, H. A. (2025b). Phyto-Fabrication of Zinc-oxide nanoparticles using Senna occidentalis: comprehensive characterization, phytochemical profiling and antimicrobial assessment [Preprint]. ChemRxiv. DOI: 10.26434/chemrxiv-2025-9kmtp.

Varshney, R., Kale, R. K. (1990). Effects of calmodulin antagonists on radiation-induced lipid peroxidation in microsomes. Int J Radiat Biol, 58(5), 733-743.

Wang, L., Hu, C., Shao, L. (2017). The antimicrobial activity of nanoparticles: present situation and prospects for the future. Int J Nanomedicine, 12, 1227-1249.

Wang, X., Zhang, Y., Zhu, H. (2021). Systemic inflammation mediates the association of heavy metal exposures with liver injury: A study in general Chinese urban adults. Ecotoxicol Environ Saf, 220, 112346.

Williamson, G., Coppens, P., Serra-Majem, L., Dew, T. (2011). The role of polyphenols in modern nutrition. Nutr Bull, 36(1), 5-12.