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TEPHROSIA PURPUREA (L.) PERS.: ETHNOMEDICINAL USES, PHYTOCHEMISTRY, PHARMACOLOGICAL EVIDENCE, QUALITY CONTROL AND TRANSLATIONAL CHALLENGES: A NARRATIVE REVIEW

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ABSTRACT

Tephrosia purpurea (L.) Pers. (Fabaceae), commonly known as Sarapunkha or Sharpunkha, is a medicinal herb used in several South Asian traditional systems. The supplied literature describes a broad range of ethnomedicinal applications and reports experimental investigations of antioxidant, antimicrobial, anti-inflammatory, hepatoprotective, antidiabetic, nephroprotective, antiulcer, anthelmintic, antiplasmodial and antiproliferative effects. Phytochemical investigations have reported flavonoids and prenylated flavonoids, isoflavones, rotenoids, triterpenoids, saponins, sterols and other constituents. Analytical studies using HPTLC, HPLC-PDA, UV-visible spectroscopy, FTIR and GC-HRMS have begun to address identification and chemical variability, including seasonal variation in selected markers. The evidence base is nevertheless heterogeneous: studies use different plant parts, extraction solvents, models, doses and endpoints, while much of the pharmacological evidence remains preclinical. Of particular importance, rotenone has been reported in the plant and its concentration varies with season and extract; this raises a material safety and standardisation issue that should be addressed rather than assuming that a botanical origin guarantees safety. This narrative review organises the supplied literature by traditional use,

phytochemistry, pharmacological activity, analytical quality control and research gaps. The findings support further systematic investigation but do not establish clinical efficacy or safety in humans. Standardised botanical material, validated multi-marker assays, toxicological characterisation, reproducible pharmacology and appropriately designed clinical studies are priorities for translation.

KEYWORDS: *Tephrosia purpurea*; Sarapunkha; ethnomedicine; phytochemistry; pharmacological activity; quality control; rotenone; herbal standardization.

1. INTRODUCTION

Medicinal plants remain important sources of traditional healthcare practices and chemical leads for drug discovery. *Tephrosia purpurea* (L.) Pers., a member of Fabaceae, is described in the supplied literature as a widely distributed herb occurring in the Indian subcontinent and other tropical and subtropical regions. In Ayurveda it is known as Sarapunkha and is associated in traditional descriptions with wound-related applications; Unani literature also records its use as a single drug and as an ingredient in formulations. Ethnobotanical reports document the use of roots, stems, leaves and seeds for a range of complaints, including gastrointestinal disorders, skin conditions and splenic enlargement.[1, 11, 17, 36]

Earlier reviews have summarised the plant's ethnopharmacology, phytochemistry and reported pharmacological activities.[14, 23, 35–37, 40, 41] Subsequent work has expanded the evidence base through disease-model experiments, isolation of individual compounds, chromatographic marker analysis and computational approaches. The purpose of this review is to synthesise the supplied article summaries into a critical, activity-oriented account, distinguish traditional claims from experimental findings, and identify methodological and translational priorities. This is a narrative review based on the references and abstracts provided by the author; it is not a systematic review and no independent database search or full-text risk-of-bias assessment was undertaken.

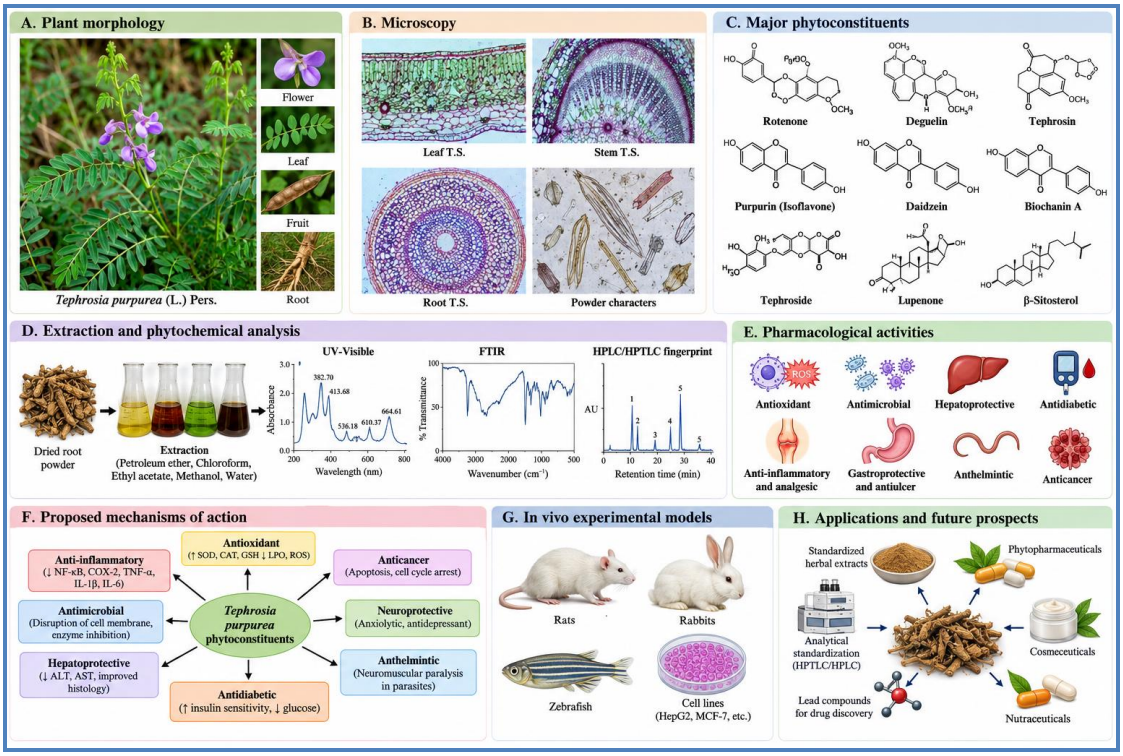


Figure 1: Overview of the botanical characteristics, phytochemical constituents, analytical profiling, reported pharmacological activities, proposed mechanisms of action, experimental models, and potential applications of *Tephrosia purpurea* (L.) Pers.

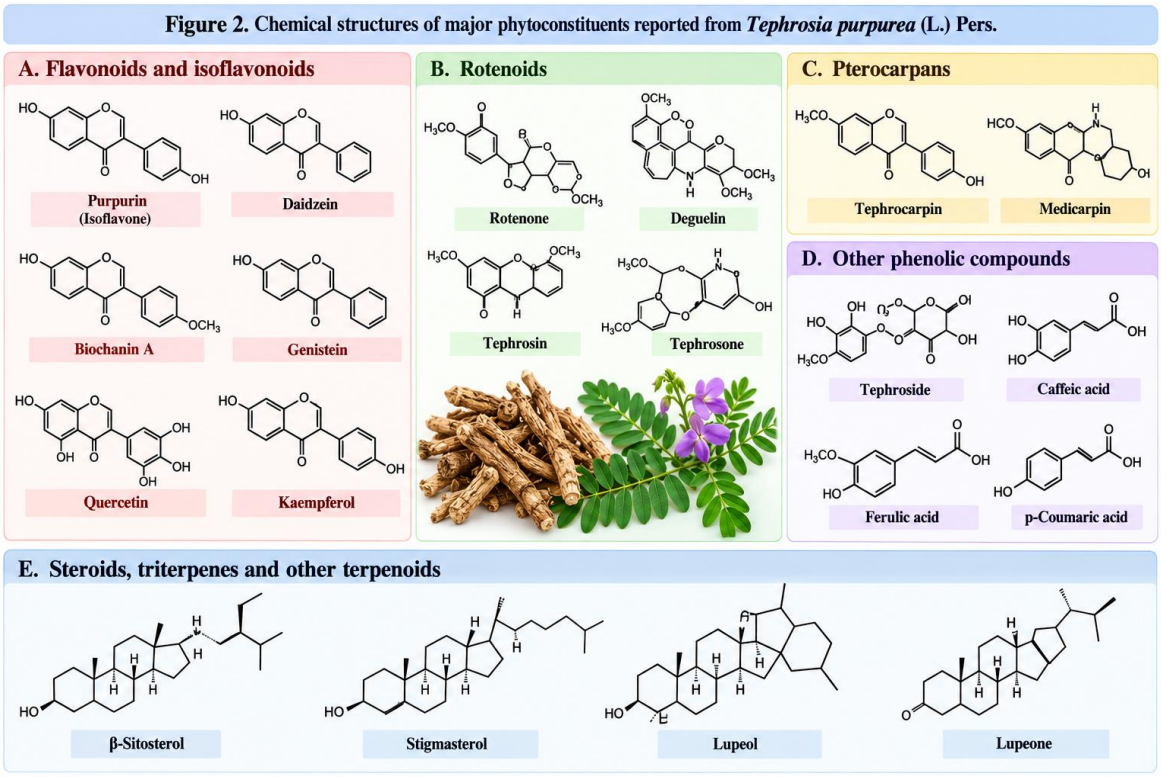


Figure 3. Reported pharmacological activities of *Tephrosia purpurea* (L.) Pers. and their proposed mechanisms of action.

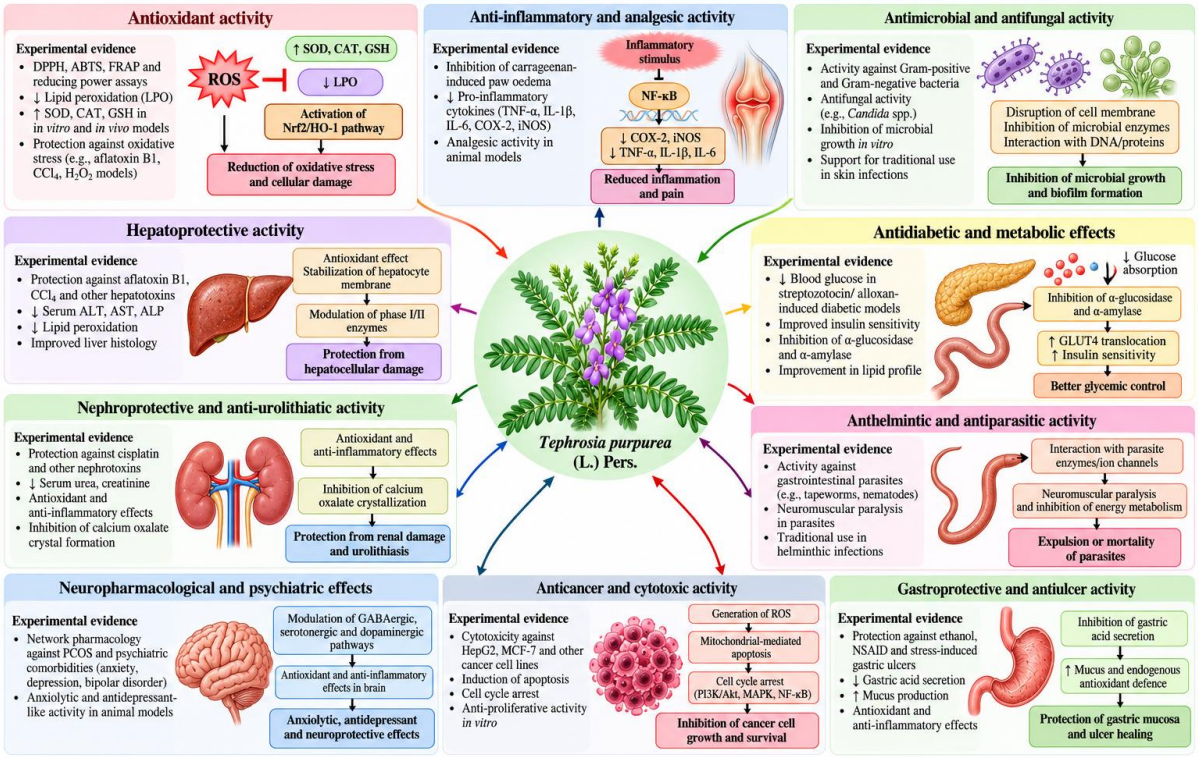
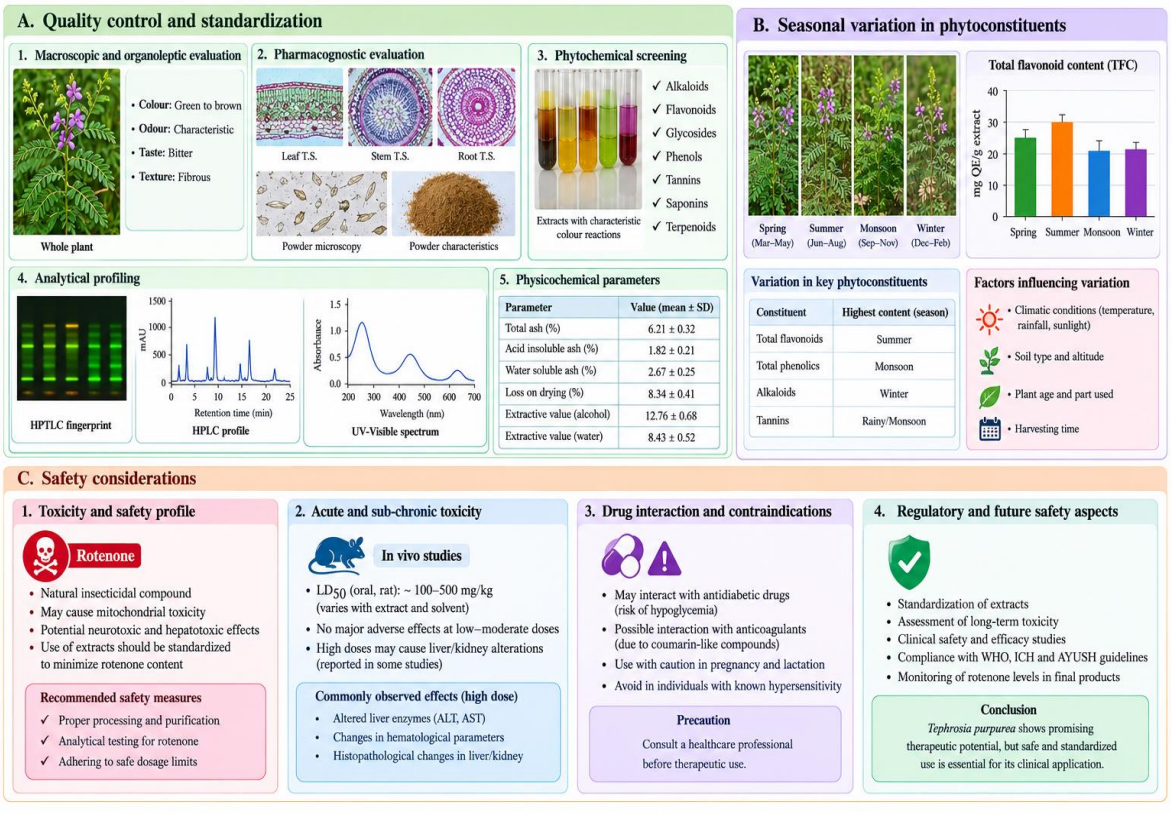


Figure 4. Quality control, seasonal variation, and safety considerations for *Tephrosia purpurea* (L.) Pers.



2. Botanical identity and ethnomedicinal relevance

The plant is identified in the source literature as *Tephrosia purpurea* (L.) Pers., family Fabaceae, with common or traditional names including Sarapunkha, Sharpunkha, Sarphuka and wild indigo. Reported habitats include wastelands and dry, sandy, gravelly or rocky soils. Ethnomedicinal use varies by region and community. A survey in Bargarh district, Odisha, recorded local use of different plant parts for chronic diarrhoea, gonorrhoea, melena, piles, splenic enlargement, oedema, asthma and several dermatological conditions.[1] Reviews of Ayurvedic and Unani practice describe uses related to liver and spleen disorders, digestive complaints, inflammation and skin conditions.[17,36] These records establish traditional relevance, but they should not be interpreted as clinical proof of effectiveness.

3. Phytochemical profile

The supplied studies report chemically diverse constituents in different plant parts and extracts. Reported classes include flavonoids, prenylated flavonoids, isoflavones, rotenoids, phenolic compounds, triterpenoids, saponins, sterols and volatile or semi-volatile compounds.[14, 21, 36, 37] Individual compounds mentioned in the literature include rutin, quercetin, lupeol, β-sitosterol, rotenone, deguelin, tephrostachin-related compounds, pongamol, purpurin, purpurintenin and tephrosin. A flavonol diglycoside, tamarixetin 3-O-β-glucopyranoside-7-O-α-rhamnopyranoside, and additional flavonoids have also been reported.[55]

The observed chemical profile depends on plant part, extraction solvent, fractionation procedure, geography and collection season. Quantitative studies comparing seasons found higher total phenolic and flavonoid content in 95% ethanolic material collected during the rainy season (August), whereas winter samples and 50% hydroalcoholic extracts showed lower values in the reported study.[30] Seasonal HPTLC analysis similarly found variation in lupeol, β-sitosterol and rotenone, with a warning that winter-collected material in that study contained relatively high rotenone.[15] Consequently, describing the species as chemically uniform is not justified; reproducible pharmacology requires defined botanical provenance and chemical characterization.

4. Pharmacological evidence

4.1 Antioxidant and oxidative-stress-related effects. Several in vitro studies report radical-scavenging or total antioxidant activity in aqueous, ethanolic, methanolic and other extracts. Antioxidant outcomes have been measured using DPPH and other assays, and some studies

report associations between total phenolic content and radical-scavenging activity.[12, 22, 30] In animal models, extracts or fractions have been reported to alter oxidative-stress markers, including glutathione, superoxide dismutase, catalase and lipid peroxidation, in aflatoxin- or nephrotoxin-associated injury.[4, 39, 43] These findings are consistent with antioxidant potential in experimental systems, but chemical assays alone cannot establish in vivo benefit, and different assays are not directly interchangeable.

4.2 Antimicrobial and antifungal activity. Hydroalcoholic and organic-solvent extracts have been investigated against bacterial pathogens, while other studies report antifungal activity and antimicrobial effects associated with isolated flavonoids or saponin-containing fractions.[2, 22, 33] Endophytic fungi isolated from T. purpurea have also shown activity against selected plant-pathogenic fungi, suggesting that the plant-associated microbiome may be a separate source of bioactive leads.[34] The studies differ in extraction methods, test organisms and concentrations; therefore, broad claims of clinical antimicrobial efficacy would be premature. Future reports should include standardised inocula, appropriate positive and negative controls, MIC/MBC values, reproducibility and comparison with relevant reference agents.

4.3 Antidiabetic and metabolic effects. In streptozotocin-induced diabetic rodents, aqueous extracts and flavonoid-rich or n-butanol-soluble fractions have been reported to improve glycaemic and lipid-related parameters. One study described improved pancreatic islet β-cell morphology following treatment with an ethanol-derived n-butanol fraction, with rutin proposed as a contributing constituent.[7] Other work reported improvements in diabetes-associated cardiovascular markers and lens oxidative status.[29, 32] These results suggest hypotheses concerning metabolic and antioxidant mechanisms, but the experimental models do not establish efficacy for human diabetes. Standardisation of active fractions, pharmacokinetic data, dose justification and safety studies are needed before clinical translation.

4.4 Hepatoprotective and chemo-preventive effects. Hepatic protection is a recurring theme in the traditional-use literature and experimental studies. Reports describe changes in biochemical and histological indices in toxin-associated liver injury, including aflatoxin B1 models[4], and investigations have examined antihepatotoxic activity of aqueous callus-culture extracts.[45] Chemopreventive activity has also been evaluated in chemically induced hepatocarcinogenesis in rats.[48] These models provide preclinical signals, not evidence that

the plant prevents or treats human liver disease. The chemical variability of extracts and the need to monitor potentially toxic constituents are particularly important in this area.

4.5 Nephroprotective and anti-urolithiasis activity. Studies in gentamicin- and arsenic-associated renal injury report improvements in selected serum biochemical measures, oxidative-stress indices and renal histology after extract treatment.[39, 43] Root extracts have also been investigated in ethylene-glycol-induced renal calculi, with reported reductions in urinary calcium, oxalate and phosphate and protection of renal tissue.[27] These findings are promising but remain model-specific. Studies should clarify whether effects are reproducible across independently prepared batches and whether the doses used have an adequate safety margin.

4.6 Anti-inflammatory, analgesic, spasmolytic and respiratory effects. Extracts of aerial and root parts have been studied for anti-inflammatory and analgesic effects. Pharmacological experiments using isolated rabbit jejunum and tracheal preparations reported concentration-dependent relaxation, with findings interpreted as potentially consistent with calcium-channel blockade.[42] However, another reported rat study did not observe significant reductions in paw volume or serum ceruloplasmin under its tested conditions, illustrating that findings are not uniformly positive. Better-powered studies with prespecified endpoints, dose-response analyses and replication are needed.

4.7 Gastrointestinal and antiulcer effects. Experimental studies have assessed antidiarrhoeal activity, antacid activity and antiulcer effects. In a modified artificial-stomach model, methanolic root extract reportedly produced a greater neutralisation effect and duration than sodium bicarbonate under the tested conditions.[46] In rat ulcer models, an alcoholic extract was reported to reduce ulcer indices, while a separate study examined antidiarrhoeal activity.[44] These results should be interpreted within the limits of the specific models and assay designs; they do not substitute for controlled clinical studies or established treatments.

4.8 Anthelmintic and antiparasitic activity. A root extract was evaluated against the goat tapeworm Moniezia, and an in vitro concentration of 125 mg/mL was reported to produce anticestodal activity comparable to albendazole, with histopathological damage observed in the parasite.[8] Isolated prenylflavone derivatives from T. purpurea subsp. leptostachya and terpurinflavone have also shown antiplasmodial activity against laboratory strains of

Plasmodium falciparum.[24] These results support further compound-level research but require careful evaluation of selectivity, toxicity, in vivo efficacy and relevance to veterinary or human use.

4.9 Antiproliferative and neuropharmacological leads. Leaf and root extracts inhibited growth of HepG2 hepatocellular carcinoma cells in vitro, with reported differences in IC50 values between extracts.[25] Other studies investigated cytotoxic or chemopreventive activity in cell and animal models.[22, 48] A computational network-pharmacology study identified candidate phytochemicals and targets related to polycystic ovary syndrome and psychiatric comorbidities.[5] Trans-tephrostachin derivatives have been investigated for acetylcholinesterase inhibition, and several synthetic analogues showed micromolar inhibitory activity.[10] Cell-based, docking and network analyses are hypothesis-generating tools; they do not establish anticancer, neurological or endocrine efficacy in patients.

5. Pharmacognosy and analytical quality control

Correct botanical identification is foundational for medicinal-plant research. Pharmacognostic investigations describe macroscopic and microscopic characters, including leaflet trichomes, palisade cells, vascular bundles, lignified xylem, sclerenchymatous cells and calcium oxalate crystals, together with physicochemical parameters such as ash values, extractive values and fluorescence characteristics.[21, 26] Such features can support identity testing, but a robust quality specification should also include contaminant limits and chemical fingerprints.

Chromatographic methods provide a route to more reproducible chemical quality control. A validated HPTLC method has been reported for lupeol, β-sitosterol and rotenone, with seasonal variation documented.[15] Another HPTLC method estimated rutin in different fractions, reporting the highest amount in the butanol-soluble fraction in that study.[28] HPLC-PDA coupled with chemometric analysis has been used to quantify rutin, deguelin and rotenone and to explore marker selection.[16] GC-HRMS analysis has profiled volatile and semi-volatile constituents, while UV-visible and FTIR approaches have been used for broader extract characterization.[3, 13] No single analytical method captures the entire chemical complexity of the species. A practical quality-control strategy should combine authenticated voucher material, macroscopic/microscopic identity, chromatographic fingerprinting, quantitative marker assays and targeted testing for toxicologically relevant compounds.

6. Safety considerations

Safety cannot be inferred from traditional use or from the fact that an extract displays a biological effect. The supplied literature includes cytotoxicity observations and studies of toxicant-associated organ injury, but these are not substitutes for a structured safety package. Rotenone is especially important: the seasonal HPTLC study reported variation in rotenone content and highlighted potential toxicological concern.[15] Therefore, plant part, harvest season, extraction solvent and processing conditions should be documented, and rotenone should be measured when relevant to the intended product. Acute and repeated-dose toxicity, genotoxicity where appropriate, reproductive toxicity for relevant indications, interaction potential and exposure margins should be assessed using validated methods. Until adequate evidence is available, the reviewed preclinical findings should not be presented as a basis for self-medication or for replacing standard treatment.

7. Limitations of the current evidence

The literature summarized here has several recurring limitations. First, studies use heterogeneous plant parts, solvents, fractions, doses, models and endpoints, which prevents straightforward comparison. Second, many reports are in vitro or animal studies, and clinical evidence is not established by the supplied summaries. Third, phytochemical identification and quantification are inconsistent across reports; some studies use preliminary screening while others use validated chromatography. Fourth, abstract-level information does not always provide sample sizes, complete statistical methods, blinding, randomisation, extract yield or full toxicology data. Fifth, multiple reviews repeat broad activity claims, so the primary experimental studies should be prioritised when assessing efficacy. These constraints mean that the present article maps the reported evidence rather than providing a quantitative estimate of therapeutic effect.

8. Research priorities and translational roadmap

Future work should begin with authenticated, voucher-supported plant material and standard operating procedures for collection, drying, storage and extraction. Multi-site and multi-season sampling should quantify chemical variation and identify practical acceptance ranges for marker compounds. Validated HPTLC/HPLC/LC–MS methods should be used to establish fingerprints and quantify both candidate bioactive markers and relevant toxic constituents. Pharmacological studies should employ chemically characterised batches, justified doses, appropriate comparators, blinded outcome assessment and independent

replication. Mechanistic claims should be tested experimentally rather than inferred solely from docking or network analysis. Safety studies should be integrated early, particularly where extracts are intended for chronic use. Only after reproducible preclinical efficacy and adequate toxicology should indication-specific clinical development be considered. Reporting should follow accepted standards for botanical identity, extract characterisation, experimental design and transparent data availability.

9. CONCLUSION

Tephrosia purpurea is a traditional medicinal plant with a chemically diverse profile and a substantial body of preclinical research spanning antioxidant, antimicrobial, metabolic, hepatic, renal, gastrointestinal, antiparasitic and antiproliferative endpoints. The most useful development signals are accompanied by important caveats: chemical composition varies with plant part, solvent and season; the evidence is heterogeneous and predominantly preclinical; and rotenone content creates a specific quality and safety consideration. Progress toward a reproducible herbal product or drug lead will depend on authenticated raw material, validated multi-marker standardisation, rigorous toxicology, reproducible mechanism-focused studies and appropriately designed clinical investigations. At present, the evidence supports further research, not claims of established clinical efficacy.

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