



Linking Phytochemical Profiles to Pharmacological Outcomes: A Prerequisite for Evidence-Based Ethnopharmacology and Phytomedicine

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Dear Editor

Ethnobotany and ethnopharmacology are complementary disciplines at the interface of traditional knowledge and biomedical science. Ethnobotany documents the cultural and ecological relationships between human societies and medicinal plants, while ethnopharmacology investigates the pharmacological basis of traditional plant use (Heinrich et al., 2017, Saki & Pourrahim, 2025). In recent decades, phytomedicine has expanded rapidly, yet a

persistent methodological limitation remains: pharmacological evaluations are frequently conducted without adequate phytochemical characterization of the tested materials (Atanasov et al., 2021). This disconnect weakens scientific rigor and limits the interpretability and reproducibility of reported findings.

A recurring limitation is the reporting of biological activities of plant extracts without sufficient chemical characterization. Extraction procedures are often described with limited methodological detail, extraction yields are not reported, and

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pharmacological assays are performed without establishing the chemical composition of tested extracts (Baker, 2016). Conversely, phytochemical investigations frequently culminate in the isolation and structural elucidation of novel compounds but do not evaluate their biological relevance or contribution to the plant's reported therapeutic effects (Cragg & Newman, 2013). This separation creates a fundamental challenge. When pharmacological activity is observed in poorly characterized extracts, the active principles may be major constituents, minor metabolites, or synergistic combinations of multiple compounds (Ulrich-Merzenich et al., 2010). Without identifying these relationships, extract standardization becomes arbitrary, reproducibility is compromised, and mechanistic interpretation remains limited.

The problem extends throughout the phytomedicine pipeline. Pharmacological studies often report significant activity of crude plant extracts at defined experimental doses without specifying chemical composition. Independent laboratories may then fail to reproduce findings because variation in plant chemotype, harvesting conditions, extraction methods, or storage can substantially alter phytochemical profiles (Gertsch, 2011). Similar experiments with the same species may therefore yield divergent pharmacological results. This variability is particularly problematic for standardization and regulation of herbal products. Standardization based solely on abundant but potentially inactive marker compounds does not guarantee therapeutic equivalence. Meaningful standardization requires identifying constituents that contribute to pharmacological activity and ensuring their consistent presence in herbal preparations (Simmler et al., 2014).

Addressing this gap requires closer integration of phytochemical and pharmacological research strategies. Pharmacological studies should incorporate appropriate analytical characterization of tested extracts, including detailed extraction protocols, yield reporting, and chromatographic profiling using techniques such as HPLC, LC-MS, or GC-MS (Verpoorte et al., 2005). Chromatographic fingerprints can provide essential documentation of extract composition and facilitate comparison between independent

studies. More importantly, research efforts should aim to correlate phytochemical profiles with biological outcomes. Differences in activity observed among fractions, batches, or preparations may provide valuable opportunities to identify compounds associated with pharmacological potency. Approaches such as bioassay-guided fractionation, metabolomic profiling, and activity correlation analysis can help elucidate the chemical basis of plant-derived pharmacological effects (Atanasov et al., 2021, Heinrich et al., 2020).

Improving methodological integration requires coordinated efforts across the phytomedicine research community. Collaborative studies combining expertise in analytical chemistry and pharmacology may significantly enhance interpretability. Editorial policies that encourage adequate phytochemical characterization may further promote methodological rigor. We therefore urge the journal to consider minimum reporting standards for pharmacological studies, including: voucher specimens and taxonomic authentication; detailed extraction and processing protocols; phytochemical characterization by chromatographic fingerprinting with quantification of marker compounds; bioassay protocols with dose-response data, positive and negative controls, and selectivity or toxicity information; and deposition of raw analytical and pharmacological data in accessible repositories. Such standards align with existing reporting frameworks and would strengthen reproducibility. In conclusion, the integration of phytochemical profiling with pharmacological evaluation is not merely a methodological refinement but a fundamental requirement for credible and reproducible phytomedicine research. Establishing clear links between chemical composition and biological activity will strengthen the scientific foundation of ethnopharmacology and facilitate the translation of plant-derived therapies into evidence-based clinical practice.

Declarations Conflict of Interest

The authors declare no conflicts of interest.

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The authors certify that that this work in its final form has been thoroughly reviewed and approved for publication.

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Not applicable.

AI Use Disclosure

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