# Digital Evidence Chains for Phytopharmaceutical Claims: Connecting In Silico Evidence, Experimental Validation, Traditional Use, Safety Data, and Regulatory Logic

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## ABSTRACT

Phytopharmaceutical claims often draw on heterogeneous evidence, including botanical identity, chemical characterization, computational prediction, experimental validation, traditional use, safety data, and regulatory reasoning. However, these evidence types do not support the same kinds of claims, and their overextension can lead to unsupported statements about efficacy, mechanism, safety, or regulatory relevance. This article proposes a digital evidence-chain framework for organizing phytopharmaceutical claim support through transparent links among evidence source, method, validation status, uncertainty, claim wording, expert interpretation, and decision boundary. The framework treats in silico prediction, network inference, molecular docking, and ADMET prediction as hypothesis-generating or plausibility-supporting evidence that requires experimental validation before stronger mechanistic or translational claims are made. It also treats traditional use as contextual evidence that may inform historical and ethnopharmacological interpretation but does not establish modern clinical effectiveness or universal safety alone. Safety data, pharmacovigilance signals, adverse-event evidence, herb–drug interaction evidence, and exposure plausibility are positioned as mandatory qualifiers for responsible claim support. Regulatory logic is framed as claim-specific reasoning rather than a universal evidence hierarchy. The proposed model contributes a structured approach for aligning evidence type, claim type, uncertainty, validation gaps, safety qualification, digital provenance, and expert review in phytopharmaceutical research.

**Key Words:** *Phytopharmaceuticals, Evidence chains, In silico evidence, Experimental validation, Traditional use, Safety data*

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## INTRODUCTION

Phytopharmaceutical claims are evidence-dependent statements rather than simple descriptions of botanical origin, historical use, or pharmacological promise. Natural products remain important sources of therapeutic discovery, but their discovery relevance does not automatically justify strong claims about modern phytopharmaceutical efficacy, mechanism, safety, or regulatory acceptability [1].

A claim that a product is pharmacologically plausible, traditionally used, experimentally active, clinically supported, or regulatory-relevant requires a different evidence basis in each case.

Modern natural-product research increasingly combines chemistry, biology, informatics, pharmacology, and

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translational reasoning, creating opportunities for more systematic evidence integration. At the same time, this diversity can fragment interpretation when computational predictions, biological assays, historical records, and safety observations are presented without clear boundaries between discovery, plausibility, validation, and claim support [2]. A digital evidence-chain approach is therefore needed to connect each evidence source to the claim it can responsibly support.

Clinical evidence for herbal and phytopharmaceutical interventions also depends on transparent reporting of the intervention itself. Reporting studies of Chinese herbal medicine formula trials show that trial interpretation requires sufficient detail about the herbal intervention, because weak intervention transparency can limit the ability to judge whether the evidence applies to a specific preparation or claim [3]. This reinforces the need for evidence chains that begin with product identity and preparation context rather than with outcomes alone.

Evidence-chain integrity should also begin before clinical results are available. Protocol-level reporting in traditional medicine trials is relevant because planned intervention details, outcomes, comparators, and methodological assumptions shape later claim interpretation [4]. The aim of this article is to propose an original digital evidence-chain framework for phytopharmaceutical claims that connects product identity, chemical characterization, in silico evidence, experimental validation, traditional use, safety data, evidence provenance, uncertainty, expert review, and regulatory decision boundaries.

*Evidence chains in phytopharmaceutical research*

A digital evidence chain in phytopharmaceutical research is a structured, traceable sequence linking a product-specific claim to the evidence used to support, limit, or reject that claim. Biomedical provenance research shows that evidence reuse and interpretation depend on knowing where data came from, how they were processed, and what transformations affected them [5]. In phytopharmaceutical research, this means that claims should be linked not only to citations but also to botanical identity, preparation context, chemical characterization, method metadata, validation status, and uncertainty.

Evidence chains differ from simple literature summaries because they preserve relationships among evidence source, method, interpretation, and claim boundary. Workflow provenance research in biomedical settings indicates that provenance should include processes and workflows, not merely final outputs [6]. For phytopharmaceutical claims, this distinction is crucial because a network prediction, docking result, extract assay, adverse-event report, or traditional-use record may become misleading if detached from its method, assumptions, and context.

Digital evidence chains can also use structured representations to connect evidence entities that are often scattered across pharmacology, toxicology, clinical, and informatics sources. A knowledge graph developed for pharmacokinetic natural product–drug interactions illustrates how natural products, chemicals, enzymes, transporters, drugs, and interaction evidence can be represented as linked entities rather than isolated records [7]. In this article, such linking is interpreted as a support mechanism for transparent reasoning, not as proof that a relationship is clinically established.

Natural product–drug interaction repository work further shows that claim-relevant evidence may span chemical characterization, pharmacokinetic mechanisms, clinical study data, and interaction interpretation [8]. This supports a broader evidence-chain principle: phytopharmaceutical claims should not be evaluated from a single evidence table alone. They should be examined through connected records that show whether the evidence is product-specific, chemically interpretable, mechanistically plausible, experimentally supported, safety-qualified, and appropriate for the proposed claim wording.

*In silico and experimental evidence*

In silico evidence is valuable in phytopharmaceutical research because it can help prioritize compounds, targets, pathways, and mechanisms for further investigation. Network pharmacology approaches for medicinal plants can support multi-target hypothesis generation by mapping relationships among constituents, targets, and disease-relevant pathways [9]. Within an evidence chain, such outputs should be categorized as mechanistic hypotheses or prioritization evidence unless they are supported by product-specific characterization and downstream validation.

The interpretive boundary of network pharmacology is especially important in natural-product research because predicted networks can be affected by database incompleteness, compound misidentification, target prediction uncertainty, pathway overrepresentation, and insufficient experimental follow-up. Recent critical discussion of network pharmacology in natural products emphasizes pitfalls that can arise when computational outputs are treated as confirmed mechanisms [10]. Therefore, the framework treats network-inferred evidence as useful but explicitly uncertainty-bearing.

Other computational approaches support different parts of the evidence chain. ADME prediction can contribute to exposure plausibility by estimating pharmacokinetic properties, drug-likeness, and medicinal chemistry characteristics, but it remains prediction-level evidence

requiring empirical confirmation [11]. Molecular docking can contribute to target-hypothesis development by modeling possible ligand–target binding, but docking evidence alone cannot establish biological activity, pathway modulation, therapeutic effect, or clinical relevance [12].

In silico ADME/Tox profiling of natural products can help identify early developability and toxicity concerns, especially when experimental resources are limited, but such predictions should be treated as screening evidence rather than definitive safety evidence [13]. Experimental validation can strengthen a computational hypothesis when it tests relevant biological activity in defined systems, as shown by natural-product studies that combine multi-target screening with experimental validation [14]. Even then, experimental bioactivity supports biological plausibility or preclinical support only within the limits of the material, assay, model, exposure context, and validation design.

**Table 1** summarises the roles and limitations of in silico and experimental evidence in phytopharmaceutical claim support.

**Table 1.** In Silico and Experimental Evidence for Phytopharmaceutical Claims: Computational Prediction, Network Inference, Molecular Docking, ADMET Prediction, In Vitro Validation, Preclinical Evidence, Mechanistic Plausibility, Interpretation Boundaries, and Validation Needs

| Evidence type | Main purpose | Claim type supported | Evidence strength | Interpretation boundary | Validation requirement | Risk of overclaiming | Framework role |
|---|---|---|---|---|---|---|---|
| Target prediction | Prioritize possible molecular targets for constituents or extracts | Discovery hypothesis claim | Hypothesis-generating | Predicted target association is not target engagement | Requires experimental target or pathway validation | Presenting predicted targets as confirmed mechanisms | Early computational prioritization |
| Network pharmacology | Map possible multi-target and pathway relationships | Mechanistic plausibility claim | Plausibility-supporting when chemically and biologically contextualized | Network proximity does not establish causality | Requires pathway, target, or phenotypic validation | Treating network diagrams as mechanism proof | Mechanism-hypothesis organization |
| Molecular docking | Explore possible ligand–target binding interactions | Mechanistic plausibility claim | Screening-level structural hypothesis | Docking fit does not establish bioactivity or efficacy | Requires biochemical, cellular, or biophysical confirmation | Treating docking output as therapeutic evidence | Target-hypothesis refinement |
| ADME prediction | Estimate pharmacokinetic and developability plausibility | Discovery or exposure plausibility claim | Prediction-level evidence | Predicted absorption, distribution, metabolism, or excretion is not measured exposure | Requires empirical pharmacokinetic or exposure evidence where stronger claims are made | Treating predicted exposure as demonstrated bioavailability | Exposure plausibility screen |
| In silico toxicity prediction | Flag possible safety concerns or liabilities | Safety-screening claim | Early risk-screening evidence | Predicted toxicity does not prove harm or safety | Requires toxicological, clinical, or pharmacovigilance follow-up | Treating absence of predicted toxicity as proof of safety | Early safety triage |
| In vitro validation | Test biological activity in controlled experimental systems | Bioactivity claim | Experimentally supportive within assay limits | Cellular or biochemical activity does not establish clinical benefit | Requires reproducibility, relevant controls, and product characterization | Extrapolating assay activity to patient benefit | Biological plausibility support |
| Preclinical evidence | Examine pharmacological or toxicological effects in non-human systems | Preclinical support claim | Translationally informative but context-limited | Preclinical effect does not establish human effectiveness | Requires exposure relevance, model suitability, and later human evidence | Treating animal or model evidence as clinical proof | Translational bridge |
| Mechanistic assay evidence | Test a specific pathway, target, | Mechanistic plausibility or | Stronger than prediction when | Mechanistic signal remains model-dependent | Requires confirmation across relevant systems | Presenting one mechanism assay as full | Mechanism-validation checkpoint |

| | | | | | |
|---|---|---|---|---|---|
| | or biological process | bioactivity claim | experimentally grounded | when stronger claims are made | therapeutic explanation |

*Traditional use and safety evidence*

Traditional use evidence is an important component of phytopharmaceutical interpretation, but it must be documented with attention to context, preparation, plant part, cultural setting, indication wording, and source quality. Recommended ethnopharmacological field-study standards emphasize that traditional medicinal knowledge should be recorded and reported with methodological care rather than reduced to unverified claims of use [15]. In the proposed framework, traditional use supports historical and ethnopharmacological context, not independent proof of modern clinical effectiveness.

Historical records can also be organized more systematically when they are treated as evidence requiring collation, interpretation, and uncertainty assessment. A pragmatic historical assessment framework for traditional plant medicines shows that documented empirical use and safety information can be gathered in a structured way, while still requiring caution when translating historical evidence into contemporary claim support [16]. This distinction helps prevent traditional continuity from being overstated as universal efficacy or safety.

Product identity and chemical characterization are essential for connecting traditional-use evidence to modern pharmacological and toxicological evidence. Best-practice guidance for chemical characterization of extracts used in pharmacological and toxicological research stresses that extract identity and composition must be sufficiently described for research interpretation [17]. In evidence-chain terms, a traditional-use record becomes claim-relevant only when the plant identity, plant part, preparation, extraction context, and chemical comparability are made explicit enough to support responsible linkage.

Safety evidence requires its own evidence chain rather than being inferred from use history or computational prediction alone. Herbal pharmacovigilance literature highlights concerns about reporting, causality, product variability, and future surveillance needs in herbal medicine safety assessment [18]. Herb–drug interaction interpretation also requires causality assessment before patient-relevant risk claims are made [19]. Pharmacovigilance database studies can inform adverse-event signals associated with herbal medicines, but such signals require uncertainty-aware interpretation because reporting patterns, product identification, exposure context, and causality may be incomplete [20].

*Regulatory logic and claim support*

Regulatory logic in phytopharmaceutical research should be understood as claim-specific evidence reasoning rather than as a single universal hierarchy applied identically to every product, preparation, or statement. Critical analysis of plant-derived supplement quality, safety, efficacy, and regulatory needs shows that responsible interpretation requires coordinated attention to product quality, risk, evidence sufficiency, and the wording of claims [21]. In the proposed evidence-chain approach, regulatory relevance is therefore not treated as a final label but as an interpretive boundary that asks what kind of evidence is needed for a particular claim to be responsibly stated.

Traditional-use evidence is especially important for botanical and phytopharmaceutical claim discussions, but its regulatory and scientific role remains contested. Stakeholder arguments about botanical health claims indicate that traditional use may contribute contextual information while raising unresolved questions about whether such evidence is sufficient for substantiating health effects [22]. The framework therefore separates traditional-use contextual claims from bioactivity claims, clinical-support claims, and regulatory-relevant claims.

The complexity of using traditional-use data to support health effects also requires careful claim wording. Critical analysis of traditional-use evidence for botanical health claims shows that historical use does not automatically demonstrate modern health effects, particularly when product identity, preparation, exposure, population, and outcome context differ [23]. Within the framework, traditional use may support historical continuity or ethnopharmacological relevance, but it should not be converted into an efficacy or safety claim without additional evidence.

Claim support also depends on the jurisdictional and product-category context in which a claim is interpreted. Comparative analysis of health-claim requirements shows that substantiation expectations differ across regulatory settings and that claim wording must be aligned with the type and quality of evidence available [24]. Regulatory frameworks for traditional, complementary, and integrative medicines further indicate that evidence requirements are context-dependent and should not be treated as equivalent to automatic authorization or acceptance [25]. Thus, a digital evidence chain should distinguish evidence assessment, claim wording, safety qualification, expert review, and regulatory interpretation boundary.

**Table 2** maps traditional use, safety evidence, and regulatory logic to responsible phytopharmaceutical claim support.

**Table 2.** Traditional Use, Safety Evidence, and Regulatory Logic for Phytopharmaceutical Claim Support: Historical Context, Ethnopharmacological Evidence, Safety Data, Pharmacovigilance, Herb–Drug Interaction Evidence, Claim Wording, Evidence Sufficiency, and Decision Boundaries

| Evidence or logic domain | Core question | Claim-support contribution | Evidence required | Safety requirement | Regulatory interpretation boundary | Uncertainty or limitation | Failure risk |
|---|---|---|---|---|---|---|---|
| Traditional use evidence | What has been historically or culturally used, and in what context? | Supports traditional-use contextual claims | Documented source, plant part, preparation, use context, and indication wording | Safety history must be interpreted separately from safety proof | Does not by itself establish modern health-effect substantiation | Context may differ from modern product and population | Treating historical use as efficacy proof |
| Ethnopharmacological evidence | Was the use recorded with adequate methodological and cultural context? | Supports historical plausibility and research prioritization | Field-study method, informant context, preparation details, and documentation quality | Risk information should be recorded where available | Supports context, not automatic regulatory acceptance | Reporting quality and cultural context may vary | Decontextualized or extractive interpretation |
| Chemical characterization | Is the studied product chemically interpretable and comparable? | Supports product-specific claim linkage | Botanical identity, extract profile, analytical method, and batch information | Toxicological interpretation requires product comparability | A claim cannot be responsibly transferred across chemically different preparations | Chemical profiles may vary by source and processing | Evidence applied to the wrong product |
| Safety data | What risks are known or plausible for the defined product and exposure? | Supports safety-qualified claims | Toxicology, contraindication, exposure, adverse-event, and interaction evidence | Risk must be product-, exposure-, and population-specific | Safety qualification is not universal safety certification | Evidence may be incomplete or population-limited | False reassurance about safety |
| Pharmacovigilance | Are there adverse-event signals requiring interpretation? | Supports risk monitoring and uncertainty qualification | Signal source, case detail, seriousness, duplicate review, and causality assessment | Signals require cautious interpretation and follow-up | Signal detection is not proof of causality or absence of risk | Underreporting and incomplete product identity are common limitations | Ignoring emerging risk signals |
| Herb–drug interaction evidence | Could the product alter exposure or response to a medicine? | Supports interaction warning or risk qualification | Interacting drug, product, mechanism, exposure, and causality evidence | Interaction risk must be assessed before patient-facing reassurance | Interaction evidence does not automatically define all clinical management | Case quality, exposure uncertainty, and confounding may limit certainty | Unsafe extrapolation to co-use contexts |
| Claim wording | Does the wording match the evidence type and evidence strength? | Converts evidence interpretation into responsible statements | Exact claim text, evidence chain, uncertainty statement, and validation gap | Safety qualifiers should accompany relevant claims | Claim wording must remain within scientific and regulatory boundaries | Ambiguous wording may imply stronger support than exists | Overstatement or implied authorization |
| Regulatory logic | What evidence is needed for the claim in its intended context? | Defines decision boundary and evidence | Product category, claim type, jurisdictional context, evidence package, and | Benefit-risk and safety context must be explicit | Regulatory relevance is not regulatory approval | Rules and expectations may vary by context | Treating scientific plausibility as authorization |

| | | |
|---|---|---|
| | sufficiency question | expert interpretation |

**Figure 1** illustrates how different evidence types support different levels of phytopharmaceutical claims, from discovery hypotheses to regulatory-relevant claim support.

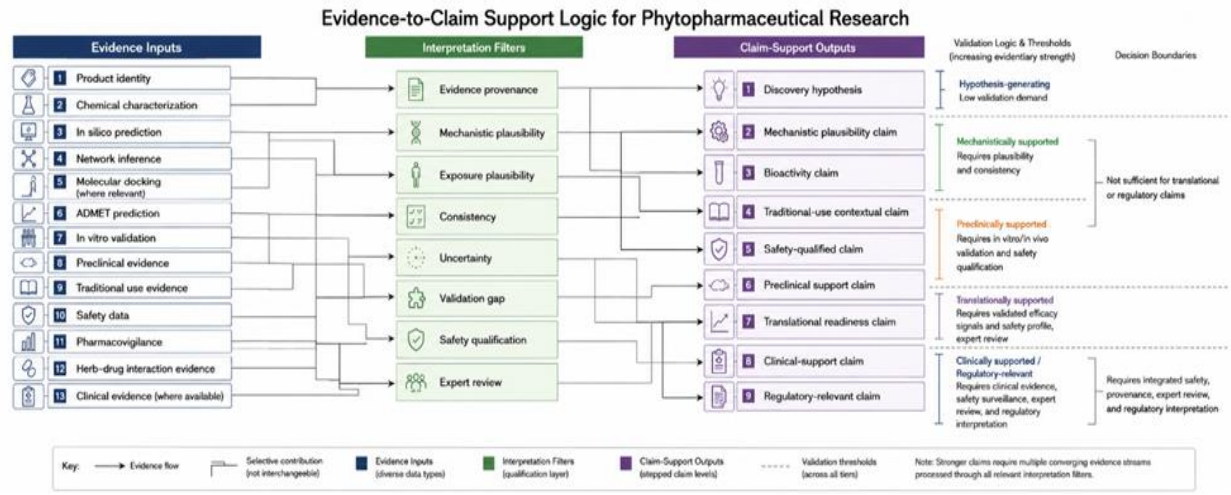


**Figure 1.** Evidence-to-Claim Support Logic for Phytopharmaceutical Research

*Alt-text description*

A claim-support logic diagram showing evidence types connected to claim levels. In silico evidence supports discovery hypotheses, experimental evidence supports biological plausibility, traditional use supports historical context, safety data qualify risk interpretation, clinical evidence supports stronger translational claims, and regulatory logic defines claim boundaries.

*Proposed evidence framework*

The proposed digital evidence-chain framework begins with phytopharmaceutical product identity and safety-relevant context. Natural product–drug interaction research recommendations show that interaction evidence requires structured attention to the product, exposure context, pharmacokinetic mechanism, and decision relevance [26]. In the framework proposed here, product identity, botanical authentication, plant part, preparation, extraction context, chemical characterization, and provenance form the entry gate before any mechanistic, safety, clinical, or regulatory-relevant claim is considered.

The second stage connects in silico prediction, experimental validation, exposure plausibility, and interaction logic. Modeling approaches for pharmacokinetic natural product–drug interactions show that decision-making can be supported when model assumptions, exposure considerations, uncertainty, and empirical evidence are made explicit [27]. Adaptation of drug–drug interaction study logic to natural product–drug interaction research further supports the need to connect prediction, clinical pharmacokinetic design, and regulatory interpretation carefully rather than assuming that conventional frameworks can be transferred without qualification [28].

The third stage is digital provenance and auditability. A provenance-driven FAIR data pipeline demonstrates how scientific workflows can be made traceable through records of source data, transformation steps, quality-control actions, versioning, and workflow history [29]. In the proposed phytopharmaceutical framework, this logic is applied conceptually to evidence chains so that a claim can be traced backward to product identity, evidence source, method, validation status, uncertainty field, expert interpretation, and decision boundary.

The fourth stage separates evidence evaluation from decision interpretation. Evidence-to-decision frameworks show that evidence assessment should be linked to explicit judgments about benefits, harms, values, certainty, feasibility, and implementation rather than treated as a purely mechanical aggregation process [30]. For phytopharmaceutical claims, this means that a digital chain should not simply accumulate evidence; it should identify what the evidence can support, what remains uncertain, what validation is missing, and what claim wording would exceed the available support.

The final stage is expert-reviewed claim alignment. This is a proposed evidence-framework element that translates the preceding stages into transparent claim-support outputs: discovery hypothesis, mechanistic plausibility claim, bioactivity claim, traditional-use contextual claim, safety-

qualified claim, preclinical support claim, translational readiness claim, clinical-support claim, regulatory-relevant claim, or decision-support claim. Each output should include a validation gap, uncertainty statement, safety qualifier where relevant, and decision boundary indicating that the framework supports responsible interpretation but does not provide medical advice, clinical authorization, or regulatory approval.

**Table 3** presents the proposed digital evidence-chain framework for phytopharmaceutical claims.

**Table 3.** Proposed Digital Evidence-Chain Framework for Phytopharmaceutical Claims: Product Identity, In Silico Evidence, Experimental Validation, Traditional Use, Safety Data, Claim Logic, Regulatory Relevance, Digital Traceability, Expert Review, and Validation Gaps

| Framework stage | Core evidence question | Required digital record | Evidence source | Claim-support function | Uncertainty field | Validation gate | Decision-support output | Failure risk |
|---|---|---|---|---|---|---|---|---|
| Product identity and context | What exactly is the phytopharmaceutical material? | Botanical name, authentication method, plant part, preparation, extraction context, batch details, and provenance | Botanical, analytical, manufacturing, or research records | Prevents evidence transfer across non-equivalent products | Identity confidence and product comparability | Botanical and product-description review | Product-specific evidence chain initiation | Misattributed evidence |
| Chemical characterization | Is the material chemically interpretable? | Analytical method, marker constituents, extract profile, batch comparability, and method metadata | Pharmacognosy, analytical chemistry, or quality-control evidence | Links chemistry to pharmacology and safety interpretation | Chemical variability and analytical completeness | Characterization adequacy review | Chemistry-supported claim boundary | Unreproducible or non-comparable claims |
| In silico evidence | What hypotheses are computationally plausible? | Input structures, database versions, models, parameters, output files, and assumptions | Target prediction, network pharmacology, docking, ADMET, or toxicity prediction | Supports discovery and mechanistic hypothesis generation | Model confidence, applicability domain, and database uncertainty | Experimental follow-up requirement | Prioritized hypothesis or validation plan | Computational overclaiming |
| Experimental validation | Has biological activity or mechanism been tested? | Assay system, material, concentration or exposure context, controls, outcomes, and reproducibility details | In vitro, biochemical, cellular, animal, or preclinical evidence | Supports bioactivity or mechanistic plausibility within model limits | Assay relevance and reproducibility uncertainty | Product-specific and model-relevance review | Bioactivity or preclinical support statement | Assay-to-claim mismatch |
| Traditional use evidence | What historical or ethnopharmacological context exists? | Source, community or historical context, plant part, preparation, indication wording, and documentation method | Ethnopharmacological field studies or historical evidence | Supports contextual or research-prioritization claims | Contextual fit and documentation completeness | Source-quality and cultural-context review | Traditional-use contextual claim | Treating use history as proof |
| Safety evidence | What risks or safety uncertainties are known? | Toxicology, contraindications, adverse events, exposure context, interaction evidence, and patient-risk factors | Toxicological, pharmacovigilance, clinical, or interaction evidence | Qualifies safety-related wording and risk interpretation | Causality, exposure, and population uncertainty | Safety-review and risk-qualification gate | Safety-qualified claim or risk flag | False reassurance |
| Claim-support logic | What claim can the evidence responsibly support? | Exact claim wording, claim type, evidence chain version, rationale, and uncertainty statement | Integrated evidence-chain review | Aligns evidence type with claim type | Claim-strength uncertainty | Claim-evidence consistency review | Responsible claim wording | Overstatement |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Regulatory relevance | What is the decision boundary for the intended claim context? | Product category, intended claim, jurisdictional context, evidence package, and review notes | Regulatory science and evidence-review literature | Defines boundary between scientific support and regulatory interpretation | Jurisdictional and category uncertainty | Expert and regulatory-logic review | Regulatory-relevant interpretation boundary | Implied approval or legal overreach |
| Expert review and audit | Has the chain been critically examined? | Reviewer comments, conflict declarations, version history, decisions, and audit trail | Multidisciplinary review | Adds accountability and prevents opaque automation | Reviewer disagreement and unresolved gaps | Independent review and update gate | Reviewed evidence-chain output | Automation bias or hidden judgment |

**Figure 2** presents the proposed digital evidence-chain framework connecting phytopharmaceutical evidence sources, validation gates, claim logic, and regulatory decision boundaries.


**Figure 2.** Digital Evidence-Chain Framework for Phytopharmaceutical Claims

*Alt-text description*

A layered digital evidence-chain framework showing phytopharmaceutical product identity and chemical characterization feeding into in silico evidence, experimental validation, traditional use evidence, safety data, claim-support logic, expert review, digital traceability, and regulatory decision boundaries.

*Practical implications*

For phytopharmaceutical researchers, natural product pharmacologists, ethnopharmacologists, computational pharmacologists, safety scientists, evidence reviewers, and regulatory scientists, digital evidence chains can make claim development more transparent by requiring explicit links between evidence type, claim wording, safety qualification, and validation gap. Stakeholder use of evidence-to-decision frameworks shows that structured judgments can support practical decision processes when evidence interpretation is made explicit rather than hidden inside informal expert opinion [31]. In phytopharmaceutical research, this implies that evidence-chain outputs should support deliberation, not replace expert judgment.

For digital decision-support platform designers, the framework provides a conceptual architecture for provenance-aware claim support. Clinical decision support literature emphasizes that digital systems can provide benefits but also carry risks related to implementation, usability, automation, and inappropriate reliance on system outputs [32]. Therefore, phytopharmaceutical evidence-chain platforms should include audit trails, uncertainty fields, safety alerts, claim-wording checks, expert-review workflows, and clear boundaries showing that decision support is not equivalent to clinical advice or regulatory authorization.

Future development should focus on standardized metadata for product identity, chemical characterization, traditional-use records, computational models, experimental validation, safety data, adverse-event evidence, interaction evidence, clinical evidence where available, and claim wording. Additional needs include claim-specific evidence grading, provenance-aware databases, validation-linked workflows, safety integration,

reproducibility checks, and expert-review interfaces. The most useful systems will likely be those that identify what evidence is present, what evidence is missing, what claims are supportable, what claims remain premature, and where further validation is needed.

## CONCLUSION

This article proposed a digital evidence-chain framework for phytopharmaceutical claims that connects product identity, chemical characterization, in silico evidence, experimental validation, traditional use, safety data, digital provenance, claim-support logic, expert review, and regulatory boundaries. The central contribution is not a new clinical or regulatory grading system, but a structured way to align evidence type with claim type while preserving uncertainty, validation gaps, safety qualification, and decision boundaries. Evidence chains can support more responsible phytopharmaceutical research claims only when computational evidence, experimental evidence, traditional-use context, safety evidence, and regulatory interpretation are treated as complementary but non-interchangeable forms of support.

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