



Curcumin-Based Interventions for Tuberculosis: A Scoping Review of Antimycobacterial, Host-Directed, Formulation, and Translational Evidence

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Abstract. *Background:* Curcumin has demonstrated antimycobacterial, immunomodulatory, formulation-enhancing, and hepatoprotective properties, yet evidence regarding its potential role in tuberculosis remains fragmented, particularly for drug-resistant disease. *Objective:* This scoping review aimed to map the extent, characteristics, mechanisms, formulations, safety findings, and translational stage of curcumin-based interventions for tuberculosis, with drug-resistant *Mycobacterium tuberculosis* as a prespecified subfocus. *Methods:* Following JBI methodology and PRISMA-ScR and PRISMA-S guidance, PubMed, Scopus, Europe PMC, and ScienceDirect were searched on 3 August 2026 without date or country restrictions. Eligible primary reports evaluated curcumin, curcuminoids, composition-characterized *Curcuma longa* extracts, synthetic analogues or complexes, formulations, or combinations in microbiological, cellular, animal, pharmacokinetic, safety, ex vivo, or human tuberculosis-related contexts. Screening and full-text eligibility were independently verified by a second reviewer, with discrepancies resolved by consensus. *Results:* Of 504 records identified, 153 duplicates were removed, 351 unique records were screened, 45 full texts were assessed, and 38 reports published between 2001 and 2026 were included. Direct antimycobacterial activity was reported in 24 studies, safety or toxicity in 23, host-directed mechanisms in 13, treatment combination or toxicity contexts in 12, formulation or delivery in nine, and drug-resistant *M. tuberculosis* in five. Synthetic derivatives or metal complexes represented the largest intervention category. Several nanoformulations improved intracellular delivery or activity, but no therapeutic clinical efficacy trial was identified. *Conclusion:* Curcumin-based interventions show biologically plausible preclinical potential, but evidence remains heterogeneous and insufficient for established therapeutic use in tuberculosis. Further standardized resistant-isolate testing, pharmacokinetic evaluation, animal validation, and early-phase clinical studies are needed before translation.

Keywords: Curcumin; Drug-Resistant Tuberculosis; Host-Directed Therapy; Nanoparticles; Tuberculosis.

1. BACKGROUND

Tuberculosis (TB) remains a major global health problem. The World Health Organization estimated that 10.7 million people developed TB and 1.23 million died from the disease in 2024. Drug-resistant TB remains a health-security threat; approximately 390,000 people developed multidrug- or rifampicin-resistant TB in 2024, and access to treatment remained incomplete [1]. These challenges sustain the need for new antimycobacterial agents, host-directed strategies, improved delivery systems, and interventions that reduce treatment-related toxicity.

Curcumin, the principal curcuminoid of *Curcuma longa*, has antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties. Prior narrative work has highlighted possible roles in direct antimycobacterial activity, modulation of host responses, enhancement of Bacille Calmette-Guérin (BCG) vaccine activity, formulation development, and mitigation of anti-tuberculosis treatment-related toxicity [2]. However, poor aqueous

solubility, rapid metabolism, limited systemic exposure, chemical diversity among analogues, and substantial variation among formulations complicate translation and comparison.

The evidence had not been comprehensively mapped across direct antimycobacterial, host-directed, formulation, pharmacokinetic, safety, animal, and human domains. This scoping review therefore aimed to characterize the available evidence on curcumin-based interventions for TB, with drug-resistant *M. tuberculosis* retained as an important prespecified subfocus rather than the dominant evidence base, and to map the gap between laboratory activity and clinical application.

2. RESEARCH METHODS

This study is a scoping review that is carried out in accordance with the JBI methodology for scoping review. Research reporting follows the PRISMA extension for scoping reviews (PRISMA-ScR), while the reporting of the literature search strategy is guided by PRISMA-S. The process of data charting, descriptive analysis, and presentation of results refers to the applicable JBI recommendations. Before the study selection process is completed, a review protocol and a structured charting framework are developed. The protocol is not prospectively registered in a public repository. Any procedural changes are recorded in the log audit and summarized as part of the research reporting.

The research questions in this scoping review are about the extent, characteristics, and level of translational maturity of evidence regarding curcumin-based interventions for tuberculosis, particularly *drug-resistant Mycobacterium tuberculosis*. The evidence reviewed covers a wide range of contexts, namely direct antimycobacterial activity, host-directed interventions, formulation, pharmacokinetics, safety, animal studies, ex vivo studies, and human studies.

Populations and models that meet the criteria include *sensitive or drug-resistant* strains of *M. tuberculosis*, cells infected with *M. tuberculosis*, animal models of tuberculosis, humans with tuberculosis, and specimens of human origin. Studies using *M. bovis* BCG or *M. smegmatis* are only included if explicitly placed as a model for the development or mechanism of tuberculosis and analyzed separately. Studies that only address non-tuberculosis mycobacterial diseases with no direct relevance to tuberculosis are excluded. Interventions that met the criteria included pure or free curcumin, curcuminoids, *Curcuma longa* extracts whose composition has been quantitatively characterized or standardized, synthetic analogues and derivatives, isotopic derivatives and metal complexes, nanoformulations and delivery systems, combination of curcumin with antituberculosis drugs, host-directed interventions,

pharmacokinetic or safety studies of explicit relevance to tuberculosis, and curcumin interventions aimed at preventing or reducing the toxicity of antituberculosis drugs. Whole turmeric powders, non-standardized extracts, and multicomponent herbal products that did not have curcumin-specific data were excluded. Studies using only docking, network pharmacology, or other computational methods without experimental validation were also excluded.

Research contexts that meet the criteria include *in vitro*, *ex vivo* studies, formulations, pharmaceutical characterization, pharmacokinetics, animal studies, and human studies. No restrictions based on year or country are applied. After documented protocol changes, only full-text reports in English are included. The types of sources used include primary and preprint experimental research reports that meet the criteria. Review articles, editorials, comments, book chapters, protocols without research results, and conference abstracts that do not have adequate methods or results are excluded from the main synthesis.

Literature searches were conducted through PubMed, Scopus, Europe PMC, and ScienceDirect on August 3, 2026. The main strategy combines the curcumin search block with the tuberculosis or mycobacteria block. Terms related to mechanism, formulation, drug resistance, and safety are not required in the search strategy because their use has the potential to reduce search sensitivity. No filters based on year, subject field, journal, or document type are applied to the main search. The full search strategy is presented in Supplementary Appendix S1. The PubMed strategy did not undergo any substantive changes during the review process. Because the CSV export from PubMed does not retain the query strings used in the metadata, it is reproduced in the Supplementary Appendix S1 based on the search logs and review notes created at the time of the study. The Scopus and Europe PMC strategies are maintained as they were executed, while ScienceDirect generates 25 citations that were exported and treated as additional platform searches. There was no separate reverse or forward citation search, handsearch, or additional grey literature search.

All records obtained from each source of information are exported and merged into the master workbook while maintaining the source origin of each record. The deduplication process is carried out by prioritizing the exact matching of DOI and PMID, followed by a comparison of normalized titles and a manual check for possible duplication. When duplicate records are found, the most complete bibliographic and abstract information is retained, while all databases that contributed to the record are recorded.

The eligibility criteria were calibrated first through a stratified trial sample before the screening process was completed. Nurul Faiqotul Hikmah (NFH) conducted an initial

screening of titles and abstracts of all 351 unique recordings based on predetermined eligibility criteria, with the help of AI that was only used to support classification at the recording level and documentation of the reasons for the decision. Furthermore, Ilham Wahid Saifurrahman (IWS) conducted a second round of independent screening of all 351 unique recordings using the same criteria. Recordings that were judged to potentially meet the criteria or were still unclear in one of the rounds were then taken in full text. The decision differences were resolved through consensus between NFH and IWS, while unresolved decisions were submitted for adjudication to Nanditya Ika Faramita (NIF) and Sonia Ayu Islami (SAI). The final classification of each record was maintained in the audit workbook. The NFH then conducts a full-text feasibility assessment and records each report as included or excluded with one primary reason for each report issued. IWS independently conducts a second round of verification of all 45 full-text eligibility decisions. At the full-text stage, verification of language, intervention characterization, primary research status, relevance of organisms, experimental validation, and relevance to tuberculosis are performed. Discrepancies are resolved by consensus, with NIF and SAI available to adjudicate if required. The entire screening and selection process is documented to maintain an auditable track of results. Thus, the final set of studies is the result of an initial assessment followed by independent verification in the second round, rather than a screening process by a single reviewer.

The structured data charting form was developed by NFH with input from all authors and was refined iteratively during the extraction process. NFH extracted key data from the submitted reports, while NIF verified the variables that had been recorded with the full text of each study. IWS cross-examined variables related to feasibility, organism classification and resistance, and determination of key outcomes. SAI reviewed unresolved methodological or clinical interpretation problems. Discrepancies or variables that remained in doubt were resolved through targeted re-reading and consensus among the authors. Extracted variables included citation information, country, publication status, evidence level, study design, population or model, organism and resistance status, curcumin intervention class, chemical form, formulation or carrier, dose or concentration, route and time of administration, comparators, combination with antituberculosis drugs, duration, direct antimycobacterial outcomes, host-directed outcomes, formulation or pharmacokinetic outcomes, safety outcomes, key findings, translational stages, and key limitations of the study.

Formal bias risk assessment based on the study design was not conducted because the purpose of this scoping review was to map the heterogeneous coverage, characteristics, and gaps of the evidence base, rather than to calculate pooled intervention effects. However, a

structured descriptive methodological assessment was still included in the data charting process. For each report, various limitations relevant to the interpretation of the results were noted, including isolates selection and characterization of resistance, the presence or absence of validation in infected cells and animals, cytotoxicity or selectivity testing, formulation attribution, pharmacokinetic validation, reasonableness of exposure, and confirmation in humans. The descriptors were used to provide context to the evidence found and were not used as exclusion criteria.

Numerical descriptive analysis was calculated in the form of frequency and percentage using 38 reports included as denominators. Unit of analysis is a report or publication, not an individual, strain, formulation, or group of animal experiments. Intervention categories are defined mutually exclusive, while evidence domains are non-mutually exclusive so that a single report can contribute to multiple domains. Reports are mapped into the domains of direct antimycobacteria, *drug-resistant M. tuberculosis*, host-directed interventions, formulation or delivery, combination with anti-tuberculosis treatment (ATT) or treatment-toxicity, pharmacokinetics, safety or toxicity, infected animals, human or ex vivo, and surrogate or organism models. Because there is a large heterogeneity in compounds, formulations, models, doses, and outcomes, meta-analyses were not performed. The classification of each report, evidence matrix and full-text report issued are presented in detail in Supplementary Tables S1-S3.

For descriptive mapping purposes, a six-stage internal framework was used that summarized the highest levels of preclinical development represented in each report. Phase 1 includes initial discovery or screening; Stage 2 includes in vitro or cellular development, resistant isolates, initial safety validation, or initial ADME validation; Stage 3 includes formulation development without efficacy evaluation in infected animals; Stage 4 includes animal evaluation or preclinical stage; Stage 5 includes adjuvant validation in infected animals or resistant disease contexts; while Stage 6 includes integrated preclinical validation that includes pharmacokinetics, safety, drug interactions, or PK-backed adjuvant validation. The framework is not a validated technology-readiness scale. Higher stages indicate a broader preclinical characterization in the context of this review and do not mean that the intervention is getting closer to being used as clinical therapy or that it already has evidence of efficacy in humans with tuberculosis.

Changes to the review procedure are documented in the audit log. Key changes include restrictions on the full text in English due to limited translation resources, operational clarification that *Curcuma longa* extract must have quantitative curcumin or curcuminoid

content or reproducible composition characterization, separate preprint labeling, as well as clarification on two-round screening procedures, full-text verification, and data charting. The research protocol is not prospective registered. All of these changes are documented to maintain methodological transparency and are considered when interpreting the completeness, reproducibility, and potential selection bias of the evidence obtained.

3. RESULTS AND DISCUSSION

Design and Reporting

This study is a scoping review that follows the JBI methodology, with reporting based on PRISMA-ScR and search strategies guided by PRISMA-S. The process of charting data, descriptive analysis, and presentation of results refers to JBI recommendations. The charting protocol and framework were developed prior to study selection, but were not prospectively registered in a public repository. Procedural changes were recorded in the log audit.

Review Question

The research question focused on the scope, characteristics, and translational maturity of evidence regarding curcumin-based interventions for tuberculosis, specifically drug-resistant *Mycobacterium tuberculosis*. The evidence included direct antimycobacterial activity, host-directed interventions, formulations, pharmacokinetics, safety, animal research, ex vivo, and human.

Eligibility Criteria

Populations and models include sensitive and resistant strains of *M. tuberculosis*, infected cells, animal models, humans with tuberculosis, and human specimens. *M. bovis* BCG and *M. smegmatis* are used only when relevant as tuberculosis models and analyzed separately. Interventions include curcumin, curcuminoids, standardized *Curcuma longa* extracts, analogues or derivatives, nanoformulations, delivery systems, combinations with anti-tuberculosis drugs, host-directed interventions, and relevant pharmacokinetic and safety studies. Whole turmeric powders, non-standardized extracts, herbal products without curcumin-specific data, and computational studies without experimental validation were excluded. Accepted contexts include in vitro, ex vivo, formulation, pharmacokinetics, animals, and humans with no age or country restrictions. Following protocol changes, only full English texts are used. Primary and preprint sources are included, while reviews, editorials, comments, book chapters, no-result protocols, and inadequate conference abstracts are issued.

Information Sources and Search Strategy

Searches were conducted on PubMed, Scopus, Europe PMC, and ScienceDirect on August 3, 2026 using a combination of the terms curcumin with tuberculosis or mycobacteria without filters for years, subjects, journals, or document types. The full strategy is available in Supplementary Appendix S1. ScienceDirect generated 25 citations and was used as an additional search. No citation hunting, handsearching, or additional grey literature searches were performed.

Record Management and Deduplication

Records from all sources are combined in the master workbook while preserving the source origin. Deduplication is done based on DOI and PMID, then through normalized title comparison and manual checking. The most complete bibliographic and abstract information is retained and all duplicate sources are recorded.

Source Selection

The eligibility criteria were calibrated through pilot screening. NFH conducted an initial screening of 351 unique recordings with AI-support for classification and reasoning documentation, then IWS conducted an independent screening of all recordings. Studies that potentially met the criteria or were not clear were examined in the full text. Discrepancies were resolved by consensus, with NIF and SAI as adjudicators. NFH assessed 45 full texts, then IWS conducted independent verification. The selection process was documented in a trail audit.

Data Charting

The charting form was developed by NFH with the input of all authors and refined during extraction. NFH performs the primary extraction, the NIF verifies the data, the IWS examines variables sensitive to the feasibility and classification of organisms or resistance, while the SAI reviews methodological and interpretive issues. The extracted variables include study characteristics, population or model, organism and resistance, curcumin intervention, formulation, dose, route, comparator, drug combination, duration, antimycobacterial outcomes, host-directed, pharmacokinetics, safety, key findings, translational stage, and limitations.

Critical Appraisal and Methodological Context

Formal risk assessment of bias was not undertaken because the purpose of scoping review was to map heterogeneous evidence coverage, characteristics, and gaps, rather than to quantify combined effects. However, methodological limitations of each report remained noted, including characterization of resistance, validation in cells or animals, cytotoxicity, formulation, pharmacokinetics, reasonableness of exposure, and confirmation in humans

Analysis and Presentation

The descriptive analysis used the frequency and percentage of the 38 reports as denominators. The unit of analysis is a report or publication. The categories of interventions are mutually exclusive, while the domains of evidence may overlap. Reports are mapped by antimycobacterial activity, drug resistance, host-directed, formulation, combination of ATT, pharmacokinetics, safety, infected animals, human or ex vivo, as well as organism models. Due to the heterogeneity of compounds, formulations, models, doses, and outcomes, meta-analyses were not performed. Detailed results are available in Supplementary Tables S1-S3.

For preclinical development mapping, a six-stage framework is used, ranging from initial discovery or screening to integrated preclinical validation supported by pharmacokinetics, safety, drug interactions, or adjuvant validation. This framework is internal and not a validated technology-readiness scale. Higher stages indicate a broader preclinical characterization, not evidence that therapies are getting closer to being used clinically or effectively in humans with tuberculosis.

Protocol Amendments

Procedural changes were noted in the log audit, including restrictions on the English full-text, quantitative characterization requirements or Curcuma longa composition, separate preprint labeling, as well as clarification of two-stage screening, full-text verification, and data charting. Protocols were not registered prospectively. All changes were considered in interpretation of completeness, reproducibility, and potential selection bias.

Report	Country	Evidence level/design	Population/model	Organism/resistance	Curcumin-based intervention	Formulation/carrier	Highest operational translational stage
Dutra et al., 2026	Brazil	In vitro; Synthesis and biological evaluation of Ag(I)-natural product complexes	M. tuberculosis culture; human cell lines	M. tuberculosis H37Rv; Drug-susceptible for the curcumin complex	Curcumin-derived metal complex: [Ag(PPH3)2(cur)] complex	Silver(I)-curcumin-triphenylphosphine complex	Stage 1: Dis
Lara-Espinosa et al., 2025	Mexico	In vitro; cellular; animal; Direct activity, checkerboard combination, infected macrophage, and adjunctive mouse study	MH-S macrophages; male BALB/c mice	H37Rv and an MDR clinical isolate; Drug-susceptible and MDR	Natural curcumin adjunct: Free curcumin	Non-nanoformulated	Stage 5: Adjunctive validation in infected ani
Lei et al., 2025	China	Formulation; in vitro; aerosol delivery; Curcumin-cinnamon essential oil nanoemulsion development and antimycobacterial testing	H37Rv; M. smegmatis; RAW 264.7 macrophages; aerosol deposition model	M. tuberculosis H37Rv and M. smegmatis; Drug-susceptible; no resistant isolate tested	Defined natural-product combination nanoformulation: Curcumin in Cur-CEO nanoemulsion	Curcumin-cinnamon essential oil nanoemulsion	Stage 3: Formulation enablement
Das et al., 2024	India	In vitro discovery; cytotoxicity; Docking-guided synthesis and biological testing of curcumin-metal complexes	H37Rv culture; ATCC CCL-81 cells	M. tuberculosis H37Rv; Drug-susceptible	Curcumin-metal complex: Curcumin-Cu and other transition-metal complexes	Metal coordination complexes	Stage 1: Dis
De Maio et al., 2023	Italy	In vitro; formulation; Graphene, curcumin, and graphene-curcumin textile coating study	Cotton and polyester textile surfaces	M. smegmatis mc2 155 used as an MTB surrogate; Not applicable; surrogate organism	Curcumin-containing surface formulation: Curcumin coating	Graphene-curcumin textile coating	Stage 3: Formulation enablement
Gupta et al., 2023	India	Cellular; formulation; pharmacokinetic; Curcumin and PLGA-curcumin nanoparticle testing in infected macrophages plus mouse PK	RAW 264.7 macrophages; BALB/c mice for PK	H37Rv and two MDR clinical isolates; Drug-susceptible and MDR	Natural curcumin and targeted nanoformulation: Free curcumin and ISCurNP	PLGA curcumin nanoparticles	Stage 6: Translations and adjunct validation
du Preez et al., 2023	South Africa	In vitro discovery; Synthesis and antitubercular structure-activity evaluation of arylnitro monocarbonyl analogues	MTB cultures in ADC and CAS media	M. tuberculosis laboratory strains; Drug-susceptible	Synthetic curcumin analogue: Arylnitro monocarbonyl curcumin analogues	Small-molecule analogues	Stage 1: Dis
Anjana and Kathiravan, 2022	India	In vitro discovery; Hydrogen-deuterium exchange in curcumin followed by physicochemical prediction and antimicrobial testing	M. tuberculosis H37Rv culture and other bacterial/fungal organisms	M. tuberculosis H37Rv; Drug-susceptible	Synthetic curcumin derivative: Deuterated curcumin	Small-molecule isotopic derivative	Stage 1: Dis
Chuang et al., 2022	Taiwan	Human ex vivo; In vitro self-controlled study of cytokine production in PPD-stimulated PBMCs	PBMCs from 18 patients with AFB-positive, culture-confirmed pulmonary TB; participants had received anti-TB chemotherapy for less than 7 days	Patient TB confirmed by M. tuberculosis culture; PPD stimulation without live-MTB infection; Not reported	Composition-characterized Curcuma longa extract: Aqueous Curcuma longa L. extract; purified curcumin concentration not reported	Hot-water extract purchased from a pharmaceutical manufacturer; each gram of extract was obtained from 9.7 g original plant material; HPLC fingerprint referenced from a prior study	Stage 2: Cel validation
Galdopórpura et al., 2022	Argentina; Italy	Formulation; cellular; animal biodistribution; Mannosylated rifampicin-curcumin co-loaded micelle development and TB-relevant testing	H37Rv-infected THP-1 macrophages; female Sprague-Dawley rats	M. tuberculosis H37Rv; Drug-susceptible	Curcumin-ATT combination nanoformulation: Curcumin co-loaded with rifampicin	Mannose-decorated Soluplus polymeric micelles	Stage 4: Ani delivery and preclinical e support
Lara-Espinosa et al., 2022	Mexico	Animal; Progressive pulmonary TB mouse model	Male BALB/c mice	M. tuberculosis H37Rv; Drug-susceptible	Natural curcumin: Free curcumin solution	Non-nanoformulated	Stage 4: Ani efficacy
Li et al., 2022	China	Cellular and animal ATT-toxicity model; L-02 hepatocyte and BALB/c mouse models of isoniazid-induced hepatotoxicity with pathway validation using SIRT1 siRNA	L-02 hepatocytes; male BALB/c mice	No infection; isoniazid toxicity model; Not applicable	Natural/free curcumin: Purified curcumin, purity above 99%	DMSO-containing cell solution; olive oil with 3% DMSO in mice	Stage 4: Ani safety/toxicity
Subhedar et al., 2022	India	In vitro discovery; safety; supportive docking; Synthesis of amide-linked 3,5-bis(arylidene)-4-piperidone conjugates, XRMA antimycobacterial screening, cytotoxicity, selectivity, and InhA docking	M. tuberculosis H37Ra and M. bovis BCG cultures; human cell lines	M. tuberculosis H37Ra and M. bovis BCG; Not reported; attenuated/model organisms	Synthetic curcumin analogues: Amide-linked monocarbonyl curcumin analogues 4a-4l	Small-molecule analogues	Stage 1: Dis
Borde et al., 2021	United States; India	Formulation and solid-state characterization; Binary and ternary amorphous solid dispersions of curcumin and North 2	In vitro pharmaceutical formulation	No organism tested; TB-directed formulation; Not applicable	Curcumin-containing combination formulation: Curcumin co-formulated with indole-2-carboxamide North 2	PVP, Eudragit EPO or HPMC solid dispersions	Stage 3: Formulation enablement
Gagandeep et al., 2021	India	In vitro discovery; early ADME; Synthesis and biological evaluation of 17 water-soluble monocarbonyl curcuminoids	MTB cultures; human liver microsomes; safety assays	M. tuberculosis; Not reported	Synthetic curcumin analogues: Water-soluble monocarbonyl curcuminoids	Small-molecule analogues	Stage 2: Dis with early A
Martolia et al., 2021	India	Standardized extract; surrogate mycobacteria; Physicochemical and HPLC standardization followed by agar-well diffusion	M. smegmatis culture	M. smegmatis NCIM 5138/MTCC 6; Surrogate organism	Composition-characterized Curcuma longa extract: Dry Curcuma longa extract containing 82.41% curcumin	Standardized dry extract	Stage 1: Sur discovery
Polaquini et al., 2021	Brazil	In vitro discovery; safety; Antibacterial, stability, cytotoxicity and mechanism study of monocarbonyl analogue MAC 4	MTB and other bacterial cultures; human lung and liver cell lines	M. tuberculosis and non-mycobacterial bacteria; Not reported	Synthetic curcumin analogue: MAC 4 and related monocarbonyl analogues	Small-molecule analogue	Stage 1: Dis
Jahagirdar et al., 2020	India	Formulation; infected macrophage; Rifampicin-curcumin polymeric nanoparticle development and intracellular efficacy testing	RAW 264.7 macrophages infected with MTB	M. tuberculosis; Not reported	Curcumin-containing combination nanoformulation: Rifampicin and curcumin co-loaded nanoparticles	Polymeric nanoparticles, approximately 400 nm	Stage 3: Formulation cellular effi
Kotwal et al., 2020	India	Animal pharmacokinetic interaction; Screening of natural phenolics for effects on bedaquiline exposure, P-gp and CYP3A4	Rats; Caco-2 and enzyme assays	No organism; MDR-TB drug interaction context; MDR-TB treatment relevance	Natural/free curcumin: Free curcumin	Oral coadministration	Stage 6: Translations and drug interaction

Figure 1. Report-Level Intervention Classification and Translational Stage.

Operational translational stage represents the highest preclinical mapping level reached by each report: Stage 1, initial discovery/screening; Stage 2, expanded in vitro/cellular, resistant-isolate, early safety, or early ADME validation; Stage 3, formulation enablement without infected-animal efficacy; Stage 4, animal/preclinical evaluation; Stage 5, adjunctive validation in infected-animal or resistant-disease contexts; and Stage 6, integrated preclinical PK/safety/drug-interaction or PK-supported adjunctive validation. This internal framework is not a validated technology-readiness scale, and Stage 6 does not imply proximity to clinical therapy. Detailed dose, comparator, outcomes, and main findings remain available in the data-charting workbook.

Record ID	Study	Direct anti-MTB	Drug-resistant M. tuberculosis	Host-directed	Formulation/delivery	ATT combination	Pharmacokinetic	Safety/toxicity	Infected-animal efficacy	Human efficacy
SR-0243	Agrawal et al., 2008	Yes	No	No	No	No	No	No	No	
SR-0016	Ahmad et al., 2019	No	No	Yes	Yes	No	No	No	Yes	
SR-0098	Anjana and Kathiravan, 2022	Yes	No	No	No	No	No	No	No	
SR-0021	Bai et al., 2016	Yes	No	Yes	No	No	No	No	No	
SR-0022	Baldwin et al., 2015	Yes	Yes	No	No	Yes	No	No	No	
SR-0125	Borde et al., 2021	No	No	No	Yes	Yes	No	No	No	
SR-0236	Changtam et al., 2010	Yes	Yes	No	No	No	No	Yes	No	
SR-0011	Chuang et al., 2022	No	No	Yes	No	No	No	No	No	
SR-0068	Das et al., 2024	Yes	No	No	No	No	No	Yes	No	
SR-0008	De Maio et al., 2023	No	No	No	Yes	No	No	No	No	
SR-0028	Dutra et al., 2026	Yes	No	No	No	No	No	Yes	No	
SR-0131	Gagandeep et al., 2021	Yes	No	No	No	No	Yes	Yes	No	
SR-0012	Galdopórpóra et al., 2022	Yes	No	No	Yes	Yes	No	Yes	No	
SR-0009	Gupta et al., 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	
SR-0188	He et al., 2017	No	No	No	No	Yes	No	Yes	No	
SR-0156	Jahagirdar et al., 2020	Yes	No	No	Yes	Yes	No	Yes	No	
SR-0153	Kotwal et al., 2020	No	No	No	No	Yes	Yes	Yes	No	
SR-0010	Lara-Espinoza et al., 2022	Yes	No	Yes	No	No	No	Yes	Yes	
SR-0006	Lara-Espinoza et al., 2025	Yes	Yes	Yes	No	Yes	No	Yes	Yes	
SR-0251	Leal et al., 2003	Yes	No	No	Yes	No	No	No	No	
SR-0171	Lee et al., 2019	No	No	Yes	No	No	No	No	No	
SR-0004	Lei et al., 2025	Yes	No	No	Yes	No	No	Yes	No	
SR-0023	Li et al., 2014a	No	No	Yes	No	No	No	Yes	No	
SR-0025	Li et al., 2014b	No	No	Yes	No	No	No	Yes	No	
SR-0100	Li et al., 2022	No	No	No	No	Yes	No	Yes	No	
SR-0129	Martolia et al., 2021	No	No	No	No	No	No	No	No	
SR-0254	Méndez-Samperio et al., 2001	No	No	Yes	No	No	No	No	No	
SR-0249	Méndez-Samperio et al., 2004	No	No	Yes	No	No	No	No	No	
SR-0166	Polaquini et al., 2019	Yes	No	No	No	No	No	Yes	No	
SR-0114	Polaquini et al., 2021	Yes	No	No	No	No	No	Yes	No	
SR-0181	Safitri et al., 2018	Yes	No	No	No	No	No	No	No	
SR-0222	Singh et al., 2012	No	No	No	No	Yes	No	Yes	No	
SR-0018	Singh et al., 2017	Yes	Yes	No	No	Yes	No	Yes	Yes	
SR-0015	Singh et al., 2020 preprint	Yes	No	Yes	No	No	No	Yes	No	
SR-0192	Subhedar et al., 2017	Yes	No	No	No	No	No	Yes	No	
SR-0097	Subhedar et al., 2022	Yes	No	No	No	No	No	Yes	No	
SR-0019	Tousif et al., 2017	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	
SR-0078	du Preez et al., 2023	Yes	No	No	No	No	No	No	No	

Figure 2. Detailed Report-Level Evidence Map.

Record ID	Title	Language	Publication/full-text status	Primary exclusion reason	Rationale
SR-0002	Curcumin induces the autophagy of Mycobacterium tuberculosis-infected macrophages through PI3K/Akt/mTOR pathway	Chinese	Peer-reviewed article; Full article identified, non-English	Full text not available in English	English title and abstract were published in Chinese. This follows eligibility rule.
SR-0024	The effects of curcumin on the 19 000 Mycobacterium tuberculosis protein-induced inflammatory and apoptotic reaction and the expression of p38 mitogen-activated protein kinases in WBC264-9C macrophages	Chinese	Peer-reviewed article; Full article identified, non-English	Full text not available in English	The available full-text Chinese and was excluded amended English-language criterion.
SR-0027	Highly conjugated curcumin analog based copper complexes towards tuberculosis: synthesis, characterization and antimycobacterial activity	English	Conference abstract; Conference abstract only	Conference abstract with insufficient data	The available report is a one-page and does not provide sufficient complete safety data for reliable
SR-0060	Curcuma longa Prevents Hepatotoxicity Induced by Isoniazid and Rifampicin: An Experiment in Wistar Rats	English	Peer-reviewed article; Complete	Wrong intervention	The intervention was unstandardized powder. Curcumin or curcumin composition-characterized as a
SR-0130	MIC and MKC analysis of herbal medicine in Indonesia against mycobacterium tuberculosis	English	Peer-reviewed article; Complete	Wrong intervention	Although individual turmeric preparation was not standardized, curcumin or curcuminoids.
SR-0224	Anti-tuberculosis activity of commonly used medicinal plants of south India	English	Peer-reviewed article; Complete	Wrong intervention	Curcuma longa extracts were not characterized for curcumin or curcuminoids, intervention criterion.
SR-0259	Antibacterial activity of new structural class of semisynthetic molecule, triphenyl-phosphonium conjugated diarylheptanoid	English	Peer-reviewed article; Complete	Ineligible surrogate-only study	The study was a broad antibacterial without a sufficiently explicit T confirmation.

Table 3. Reports Excluded After Full-Text Assessment.

4. CONCLUSIONS AND SUGGESTIONS

Curcumin-based interventions demonstrate heterogeneous but biologically plausible preclinical activity against tuberculosis through direct antimycobacterial effects, host-directed mechanisms, optimized delivery, adjunctive activity, and mitigation of treatment-related toxicity. Evidence relevant to drug-resistant tuberculosis remains limited to five reports and should be interpreted as a focused subdomain rather than the dominant evidence base. Autophagy-mediated intracellular clearance has been demonstrated with H37Rv and selected MDR clinical isolates, whereas apoptosis has been mechanistically validated mainly in susceptible-strain macrophage models. Selected synthetic analogues reported low in vitro inhibitory concentrations, and several formulations improved delivery or intracellular activity, but cross-study comparisons remain constrained by assay and product heterogeneity. No therapeutic clinical efficacy trial was identified. Curcumin should therefore remain an investigational adjunctive platform requiring standardized resistant-isolate testing, lesion-relevant pharmacokinetics, drug-interaction evaluation, infected-animal validation, and early-phase clinical study before any therapeutic role can be established.

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