Medicinal plants used for diabetes-related conditions in Indonesia: a systematic review of field-based ethnobotanical use-reports, cross-study recurrence, and reporting completeness

Salwa P Qurrotuaini, Raden M Febriyanti, Sandra Megantara, Yaya Rukayadi, Mushtaq Ahmad, Saraj Bahadur, Ajeng Diantini

Correspondence

Salwa P Qurrotuaini[1,2], Raden M Febriyanti[3], Sandra Megantara[4], Yaya Rukayadi[5], Mushtaq Ahmad[6], Saraj Bahadur[7], Ajeng Diantini[2*]

[1]Master of Pharmacy Study Program, Faculty of Pharmacy, Universitas Padjadjaran, Sumedang, West Java, Indonesia.
[2]Department of Pharmacology and Clinical Pharmacy, Universitas Padjadjaran, Sumedang, West Java, Indonesia.
[3]Department of Pharmaceutical Biology, Universitas Padjadjaran, Sumedang, West Java, Indonesia.
[4]Department of Pharmaceutical Analysis and Medicinal Chemistry, Universitas Padjadjaran, Sumedang, West Java, Indonesia.
[5]Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia.
[6]Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan.
[7]State Key Laboratory of Herbage Improvement and Grassland Agro-ecosystems, College of Ecology, Lanzhou University, Lanzhou 730000, China

*Corresponding Author: ajeng.diantini@unpad.ac.id

Ethnobotany Research and Applications 36:39 (2026) - http://dx.doi.org/10.32859/era.36.39.1-26
Manuscript received: 16/08/2026 - Revised manuscript received: 18/11/2026 - Published: 20/11/2026

Review

Abstract

Background: A previous national review has synthesized Indonesian medicinal plants used for diabetes mellitus. This review examines recent field-based evidence at the study-taxon level, with emphasis on recurrence, geographical concentration, and reporting completeness.

Methods: This systematic review followed PRISMA-adapted procedures and included primary ethnobotanical field studies published in Indonesia between 2015 and 2026. Searches were conducted in Scopus, PubMed, Portal Garuda, and Neliti. Included and excluded studies were determined based on the PICOS framework. Extracted variables included plant taxa, plant parts, preparation methods, routes of administration, ethnic/community distribution, ethnobotanical indices, ethical reporting, taxonomic verification, and voucher-specimen documentation.

Results: Thirty-six studies from 18 provinces contributed 202 study-taxon links and 115 taxon entries across 51 families. Thirty-eight entries occurred in at least two studies. *Orthosiphon aristatus* was reported in eight studies and *Andrographis paniculata* in seven. Explicit consent statements were recorded for 21 studies and implied consent for a further five; a herbarium name or acronym was reported for 12 studies, and a voucher specimen was explicitly mentioned for one. Diabetes-related systemic uses were distinguished from two explicitly labeled diabetic-wound records.

Conclusions: Repeated documentation identifies a shared research focus, but does not demonstrate independent cross-study consensus, therapeutic effectiveness, or safety. Future field studies require explicit ethical reporting, taxonomically authenticated vouchers, indication-specific use records, and transparent links between informants, taxa, preparations, and study settings.

Keywords: Ethnobotany, Indonesia, diabetes mellitus, medicinal plants, use-report, cross-study recurrence

Background

Indonesia represents a highly relevant setting for ethnobotanical research with its biocultural diversity, which comprises more than 1,300 ethnic groups distributed across 38 provinces (BPS 2011, 2025). This diversity forms a large and heterogeneous repository of traditional medicinal knowledge, as demonstrated by the 2017 Riset Tumbuhan Obat dan Jamu (RISTOJA), which documented 1,144 identified medicinal plant species and 1,258 unidentified plant records from 100 ethnic groups (Wahyono *et al.* 2017). Long-term disease control of diabetes mellitus (DM), which is projected to increase substantially in the coming decades (WHO 2024, IDF 2025), remains constrained by treatment adherence, perceived adverse effects, and patient preference for traditional remedies (Kemenkes BKPK 2023). These patterns indicate that diabetes management in Indonesia is embedded not only in biomedical care but also in culturally rooted therapeutic practices.

Indonesian ethnobotanical studies document plant use for diabetes, blood-sugar complaints, and diabetes-associated wounds in diverse local settings (Nuraeni *et al.* 2022, Putra *et al.* 2023, Andika *et al.* 2025, Febriyanti *et al.* 2025). These records are valuable for understanding health practices and identifying questions for further research, but community-reported illness categories do not necessarily correspond to a confirmed biomedical diagnosis (Naveen *et al.* 2021, Saensouk *et al.* 2025, Malik *et al.* 2026). A synthesis must therefore distinguish the documentation of use from evidence of therapeutic benefit and distinguish systemic diabetes remedies from topical wound care (Banerjee 2024, Murtey & Vanoh 2025).

Indonesian ethnobotanical evidence has been synthesized at two complementary levels. Arifah *et al*. (2022) provided a broad ethnopharmacological overview of plants used for diabetes mellitus by integrating ethnomedicinal records with experimental, phytochemical, and toxicological evidence. More recently, Febriyanti *et al*. (2026) synthesized the ethnobotany of Indonesian medicinal plants across various disease categories and noted that, for chronic metabolic conditions such as type 2 diabetes, plant use is often dispersed across many taxa rather than concentrated in a single dominant taxon. The contribution of this review is to describe the synthesis of recent primary field studies to determine whether recurring antidiabetic taxa emerge when the evidence is extracted again at the level of disease-specific use reports.

The term diabetes-related conditions include explicit references to diabetes mellitus, hyperglycemia/hyperglycaemia, or blood sugar, along with records explicitly translated as diabetic wound treatment (Naveen *et al.* 2021, Malik *et al.* 2026). Study-level use reports demonstrate unique taxon-study associations, distinguishing publication discrepancies from independent cultural attributions or clinical observations (Febriyanti *et al.* 2026). By limiting the unit of analysis to field-based reports, this diabetes-focused synthesis addresses methodological as well as cultural aspects of the evidence, identifying where ethical documentation, voucher-based botanical traceability, and conservation reporting remain inadequate in Indonesian ethnomedicine.

Therefore, the primary objective of this systematic review is to describe the plant inventory and use attributes reported for diabetes-related conditions in Indonesia and to gauge their prevalence across independent studies and provinces. Furthermore, this study aims to describe how recurrence is distributed across studies and provinces, including the contribution of individual large studies; to characterize the comprehensiveness of ethical, botanical, and quantitative ethnobotanical reporting; and to contextualize findings regarding harvest sensitivity and safety concerns, without providing clinical treatment recommendations.

Materials and Methods

Review design and eligibility criteria

This systematic review used a PICOS-based eligibility framework (Table 1) and PRISMA 2020 reporting principles (Page *et al*. 2021). Eligible publications reported primary ethnobotanical fieldwork with human informants in Indonesia and extractable plant use for an eligible diabetes-related indication. The publication window began in 2015 and ended at the documented search cutoff of 14th October 2026.

Full-length journal articles and full conference papers with primary field data were eligible. Reviews, conference abstracts without extractable primary data, non-medicinal ethnobotany, and exclusively laboratory, animal, agronomic, or other non-field investigations were excluded. Studies lacking an extractable taxon-diabetes-use association were excluded from both narrative and descriptive synthesis. Because the included studies were heterogeneous in study design, informant recruitment, ethnobotanical data structure, terminology for diabetes-related conditions, and outcome reporting, the synthesis was limited to qualitative and descriptive quantitative analysis. No meta-analysis was performed because the extracted data did not provide comparable effect estimates or standardized quantitative outcomes suitable for statistical pooling (Page *et al.* 2021).

Eligibility criteria were developed using the PICOS framework to define the scope of the review and ensure consistent study selection (Table 1).

Table 1. PICOS eligibility criteria

PICOS Component	Eligibility definition
Population	Human informants or communities in Indonesia.
Intervention / Exposure	Medicinal-plant use documented by primary ethnobotanical fieldwork.
Comparator	Comparator data were not mandatory for inclusion.
Outcomes	Medicinal plant taxa used for diabetes-related conditions and associated ethnobotanical variables, including local names, plant parts used, preparation methods, routes of administration, use categories, and ethnobotanical indices, where reported.
Study design / Setting	Original, field-based ethnobotanical studies conducted in Indonesia and published between 2015 and 2026.

Search strategy

A systematic literature search covered literature indexed up to October 14th, 2026, in four electronic databases: Scopus, PubMed, Portal Garuda, and Neliti to identify primary ethnobotanical field studies conducted in Indonesia. These databases were selected to capture both internationally indexed literature and Indonesian national or regional publications relevant to ethnobotany, traditional medicinal plant use, and diabetes-related conditions. An initial broad search query based on ethnobotanical and geographical terms (e.g., "ethnobotany", "etnobotani", and "indonesia") was intentionally implemented across all four databases to avoid the inadvertent omission of primary field surveys, which conventionally publish multi-ailment floristic inventories without indexing specific diabetes-related terms. Database-specific syntaxes and filters applied (such as "All open access", "Free full text", and "Accredited journals only") are fully detailed in Supplementary File 1.

No citation searching or grey-literature search was performed. No language restrictions were applied during the initial search, provided that sufficient extractable data were available. The search was designed to retrieve studies reporting traditional medicinal plant use among Indonesian communities and to exclude studies that were exclusively laboratory-based, animal, agronomic, or otherwise lacking primary field data from human informants.

Study selection

Retrieved records were compiled in Rayyan and title-abstract screening was done by SPQ and RMF. From an initial total of 320 identified records, 22 records were removed before screening (comprising 20 duplicate records, 1 inaccessible record, and 1 record not pertaining to Indonesia). This left 298 records for the formal screening stage. During screening, a further 203 records were excluded (1 not Indonesia, 40 removed by specific keywords, and 162 excluded by title and abstract screening). This process left 95 reports sought for retrieval, all of which were successfully retrieved for full-text eligibility assessment. The recorded full-text assessment resulted in 59 exclusions (Figure 1). The 14 reports excluded for lacking extractable table data for diabetes-related ailments were part of these 59 exclusions, alongside records excluded for having a non-medicinal focus (n = 22), having a non-medicinal focus without primary fieldwork with human informants (n = 2), and lacking extractable table data for specific medicinal ailments (n = 21). Ultimately, 36 studies were included in the quantitative review.

The complete study selection process is shown in Figure 1.

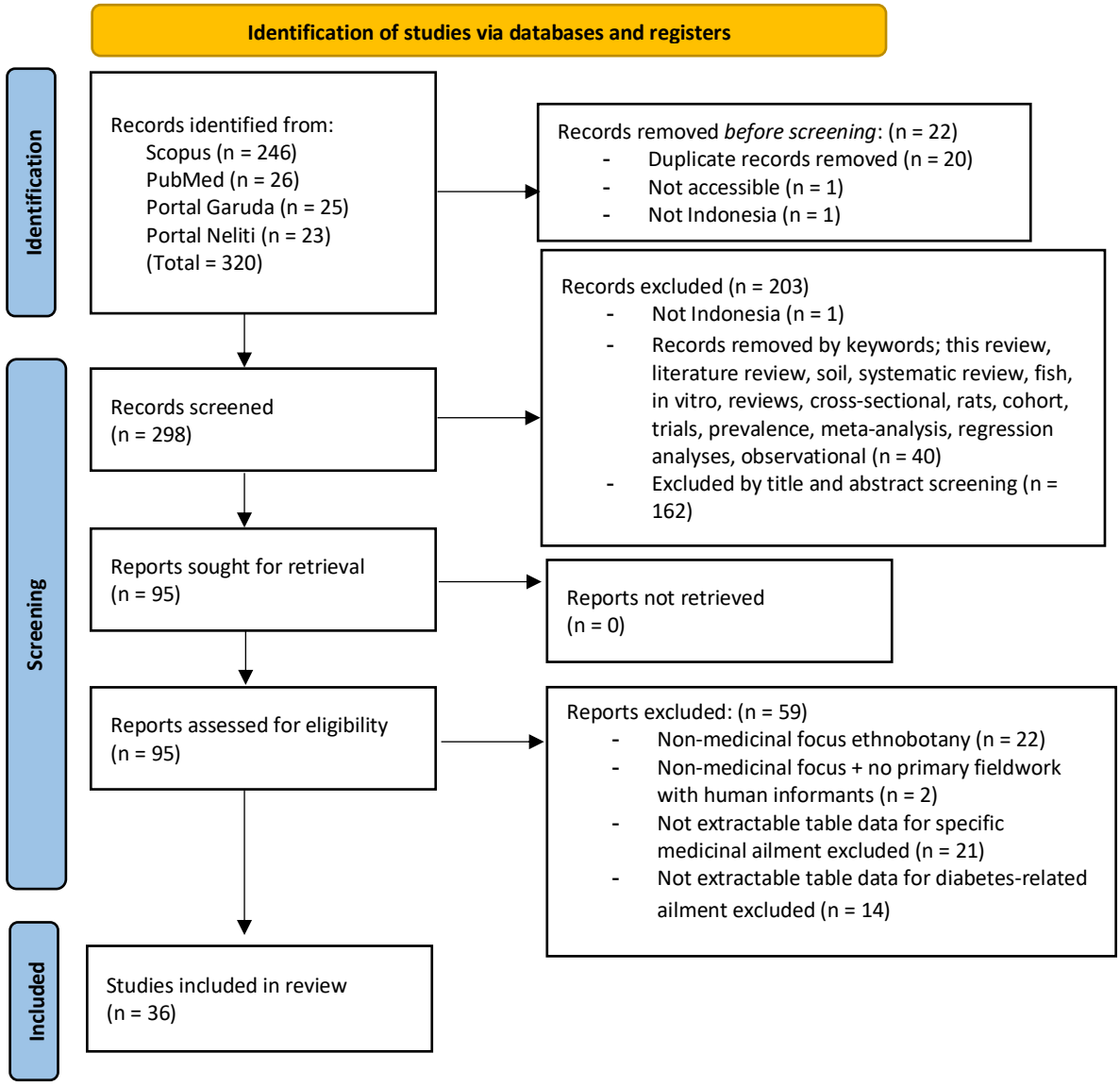


Figure 1. PRISMA 2020 flow diagram of the study selection process (adapted from Page *et al.* 2021).

Data extraction

Records from the four databases were compiled in Rayyan for deduplication and screening. Included studies were charted in a predefined Microsoft Excel extraction form built around the review objectives and PICOS framework and piloted on a subset of studies. Two reviewers (SPQ and RMF) extracted data independently, compared entries, and resolved discrepancies through discussion, while SM adjudicated unresolved cases.

Study-level items were author and year, study period, province, island/region, ethnic group or community, setting, sampling strategy, data-collection methods, number of informants, and the ethnobotanical indices used. Plant-level items were botanical name, family, local name, plant part, preparation, route of administration, and the verbatim ailment term. Items not stated in the source were coded “NR” (not reported) and not inferred. All entries were manually checked for duplicates and transcription errors, and for consistency between study-level and plant-level records.

Analytical unit

A use-report (UR) was defined as one plant taxon linked to one diabetes-related use in one included study. Eligible terms were diabetes, diabetes mellitus, hyperglycemia/hyperglycaemia, and blood sugar (including Indonesian equivalents) as stated in the source. Repeated mentions of a taxon within the same study counted once. Records explicitly labelled as diabetic wound were flagged and not treated as systemic antidiabetic use.

Data harmonization

Plant names were verified against Plants of the World Online (POWO 2026), and synonyms and misspellings were consolidated into accepted names while source names were retained. Plant parts, preparations, and routes were coded as non-exclusive categories, counted once per taxon entry. Categories were merged as follows: stem, trunk, and wood were combined; tuber and bulb were combined; skin and peel were combined; boiling and decoction were combined; pressing and juice extraction were combined; crushing, grinding, and powdering were grouped by processing type; “Loloh” and “wedang” were kept as reported labels. All frequencies were descriptive only.

Methodological Reporting

Reporting was assessed per study using Supplementary File 3. Five domains were scored: ethics approval, consent procedure, taxonomic identification method, herbarium name/acronym, and quantitative ethnobotanical indices. Consent was classified as explicit (oral, verbal, written, or FPIC), implied, or not reported, and both explicit and implied consent were scored as reported. A taxonomic identification method was scored as reported when the study described how plants were identified (e.g., flora references, expert or herbarium comparison, or name verification in an online database). One point was assigned per reported domain, giving a completeness score of 0-5 (0-1 = low, 2-3 = moderate, 4-5 = high). Voucher-specimen statements and site or community permission were recorded separately and were not included in the score.

Conservation relevance of recurrent species

A recurrent taxon was defined as one reported in at least two independent studies. Introduced or native status in Indonesia (POWO 2026), global IUCN Red List category (IUCN 2026), and CITES listing (UNEP-WCMC 2026) were recorded for each recurrent taxon. Harvested organs were described in terms of potential effects on individual plants and regeneration. Leaf or fruit collection, seed removal, bark removal, and root or whole-plant collection were considered separately. An organ alone was insufficient to assign low, moderate, or high local harvesting risk because harvest intensity, collection source, population abundance, and regeneration were not consistently documented. These variables were not combined into a single score.

Results

Overview of Included studies

A total of 36 primary ethnobotanical studies published between 2015 and 2026 were included in the synthesis (Table 2). The complete list of included studies is provided in Supplementary File 2. Most were published recently (29 studies since 2020), and all were primary field studies from 18 provinces. The studies contributed 202 study-taxon links. Asra *et al.* (2025) contributed the most (24), followed by Santhyami *et al.* (2024) with 22 species, Febriyanti *et al.* (2022) with 20 species, and Andika *et al.* (2025) with 14 species.

Purposive sampling alone was reported in 17 studies, snowball sampling alone in nine, combined purposive and snowball sampling in five, random sampling in two, purposive sampling with transect plots in one, and multistage cluster sampling in one, and no sampling strategy was reported in one. Thirty-three studies were published in English and three in Indonesian. Study-level characteristics and bibliographic identifiers are given in Table 2 and Supplementary File 2.

Data collection was mainly conducted through semi-structured interviews, observation, questionnaires, and field surveys as shown in Figure 2. Other qualitative and participatory approaches, including in-depth interviews, free-listing, focus group discussions, participatory rural appraisal, and transect-based methods, were reported less frequently. These findings indicate that most studies relied on interview-based documentation, supported in several cases by direct observation and field verification.

Table 2. Characteristics of included ethnobotanical studies

Author, Year	Study Period	Sampling	Data Collection	Informants (total)	Province	Island/ Region	Ethnic/ Tribe	Setting	Families	Species	Language
Nursamsu *et al.* 2024	2024	Purposive and snowball	SSI, Questionnaire field survey	11	Aceh	Sumatra	Aneuk Jamee	Rural	7	7	English
Albar *et al.* 2025	NR	Purposive	Interview (Open Interview and SSI), Questionnaire, observation	45	West Nusa Tenggara	Sumbawa Island, Lesser Sunda Islands	Bima	Rural	6	7	English
Rambey *et al.* 2024	NR	Purposive	SSI, Questionnaire	40	North Sumatra	Sumatra	Mandailing	Rural	8	10	English
Pratami *et al.* 2024	2023-2024	Purposive	In-depth interviews, Questionnaire, field observation	30	West Java	Java	Sundanese	Rural, peri-urban	9	9	English
Torimbanu *et al.* 2024	2023	Purposive and snowball	SSI, Questionnaire	81	Central Java	Java	Javanese	Rural	2	2	English
Darmastuti *et al.* 2024	2022	Purposive	Observation, interviews, free-listing	121	Central Java	Java	Javanese	Urban	1	1	English
Dewi *et al.* 2024	2022	Purposive and snowball	SSI, observation	30	Riau Islands	Sumatra	Akit	Rural	5	5	English
Andila *et al.* 2023	2022	Purposive	Interviews (semi-open), observation	9	Bali	Bali	Balinese	Rural	6	8	English
Khusna *et al.* 2023	2022	Purposive	SSI, observation	30	Central Java	Java	Sundanese (Jalawastu community)	Rural	1	1	English
Safitri *et al.* 2024	2023	Purposive with transect plots	Interview, observation	42	Riau	Sumatra	Malay (community)	Peri-urban	2	3	English
Sutomo *et al.* 2024	2022-2023	Purposive	SSI, Questionnaire	4	South Kalimantan	Kalimantan/ Borneo	Banjar, Javanese	Rural	3	3	English
Igustita *et al.* 2023	NR	Snowball	SSI	46	Central Java	Java	Javanese	Rural	2	3	English

Santhyami *et al.* 2024	NR	NR	SSI, Observation	40	Central Java	Java	NR	Urban	18	22	English
Rambey & Lubis 2023	2020	Snowball	Interviews	NR	North Sumatra	Sumatra	NR	Rural	3	3	English
Milad *et al.* 2023	NR	Snowball	Interviews, Questionnaires, Observation	30	Central Kalimantan	Kalimantan/ Borneo	Dayak, Banjar	Rural	1	1	English
Julung *et al.* 2023	2022	Purposive	SSI, Observation	10	West Kalimantan	Kalimantan/ Borneo	Dayak Linoh	Rural	1	1	English
Rambey & Onrizal 2022	2020	Snowball	In-depth interviews, observation	30	North Sumatra	Sumatra	Batak, Javanese, Malay, Aceh, etc.	Rural	3	3	English
Henri *et al.* 2022	NR	Snowball	Interviews, observation	37	Bangka Belitung Islands	Bangka Island	Malay	Rural	5	5	English
Rahayu & Andini 2019	NR	Snowball	SSI, Observation	31	West Nusa Tenggara	Lombok	NR	Rural	4	4	English
Sutomo *et al.* 2022	2020	Purposive	SSI, Questionnaire	2	South Kalimantan	Kalimantan/ Borneo	Dayak, Banjar	Rural	3	3	English
Husaini *et al.* 2022	2021-2022	Snowball	SSI	60	South Sulawesi	Sulawesi	Minasatene (community)	Rural	10	11	English
Suciyati *et al.* 2021	2019-2020	Snowball	SSI, Questionnaire	65	North Kalimantan	Kalimantan/ Borneo	Tidung	Rural	1	1	English
Agustina *et al.* 2022	2022	Purposive	SSI	60	East Java	Java	Javanese	Rural	3	3	English
Purwanti *et al.* 2020	2019	Purposive	Interviews, observation	45	East Java	Madura Island	Madurese	Rural	5	5	English
Rohman *et al.* 2019	2018	Purposive	FGD	NR	East Java	Java	Tengger	Rural	1	1	English
Nahdi *et al.* 2016	2014-2015	Purposive	In-depth interviews	40	Yogyakarta	Java	Javanese (Turgo	Rural	2	2	English

							village community)				
Fathurrahman *et al.* 2016	2012	Purposive	Interview, Observation	NR	Central Sulawesi	Sulawesi	Kaili Inde	Rural	2	2	English
Putri *et al.* 2016	2015	Random	SSI, Questionnaire, field-observation	47	West Java	Java	Sundanese	Urban, Peri-urban	5	7	English
Sujarwo *et al.* 2015	2013	Purposive	SSI, FGD, Questionnaire	50	Bali	Bali	Bali Aga	Rural	3	3	English
Nurotuljannah *et al.* 2024	2022-2023	Snowball	SSI, Observation	40	West Kalimantan	Kalimantan/ Borneo	Dayak	Rural	1	1	Indonesian
Oktavia *et al.* 2017	2016	Purposive	SSI, PRA, Observation, FGD	30	Bali	Bali	Balinese	Rural	1	1	Indonesian
Latifah & Fachrudin 2024	2022	Purposive and snowball	SSI, deep interview, observation	25	North Sumatra	Sumatra	Malay, Batak	Urban	5	5	English
Andika *et al.* 2025	2023	Random	SSI & direct exploration	95	Aceh	Sumatra	Acehnese, Javanese, Batak	Peri-urban	10	12 (+ 2 varieties)	Indonesian
Asra *et al.* 2025	2024	Purposive and snowball	Field observations, documentation, & in-depth interviews	> 75	Jambi	Sumatra	Javanese, Kerinci, Malay	Rural & Urban	16	24	English
Supiandi *et al.* 2026	NR	Purposive	Structured interviews, participatory observation, & field documentation	37	West Kalimantan	Kalimantan/ Borneo	Dayak	Rural	1	1	English
Febriyanti *et al.* 2022	NR	Multistage cluster	SSI & structured questions	360	West Java	Java	Sundanese	Rural & Urban	17	20	English

NR = not reported; SSI = semi-structured interview; FGD = focus group discussion; PRA = participatory rural appraisal. Families and species refer to taxa with diabetes-related use-reports.

Quantitative ethnobotanical reporting was variable across the included studies. Twenty-one studies reported at least one ethnobotanical index, whereas 15 studies did not report any quantitative index. Use value (UV) was the most frequently applied index, followed by relative frequency of citation and informant consensus factor. Other indices, including fidelity level, index of cultural significance, plant part value, family use value, informant agreement ratio, and diversity indices, were reported only sporadically. Figure 2 summarizes sampling strategies, data-collection methods, island/regional distribution, study settings, and ethnobotanical indices reported across the 36 included studies.

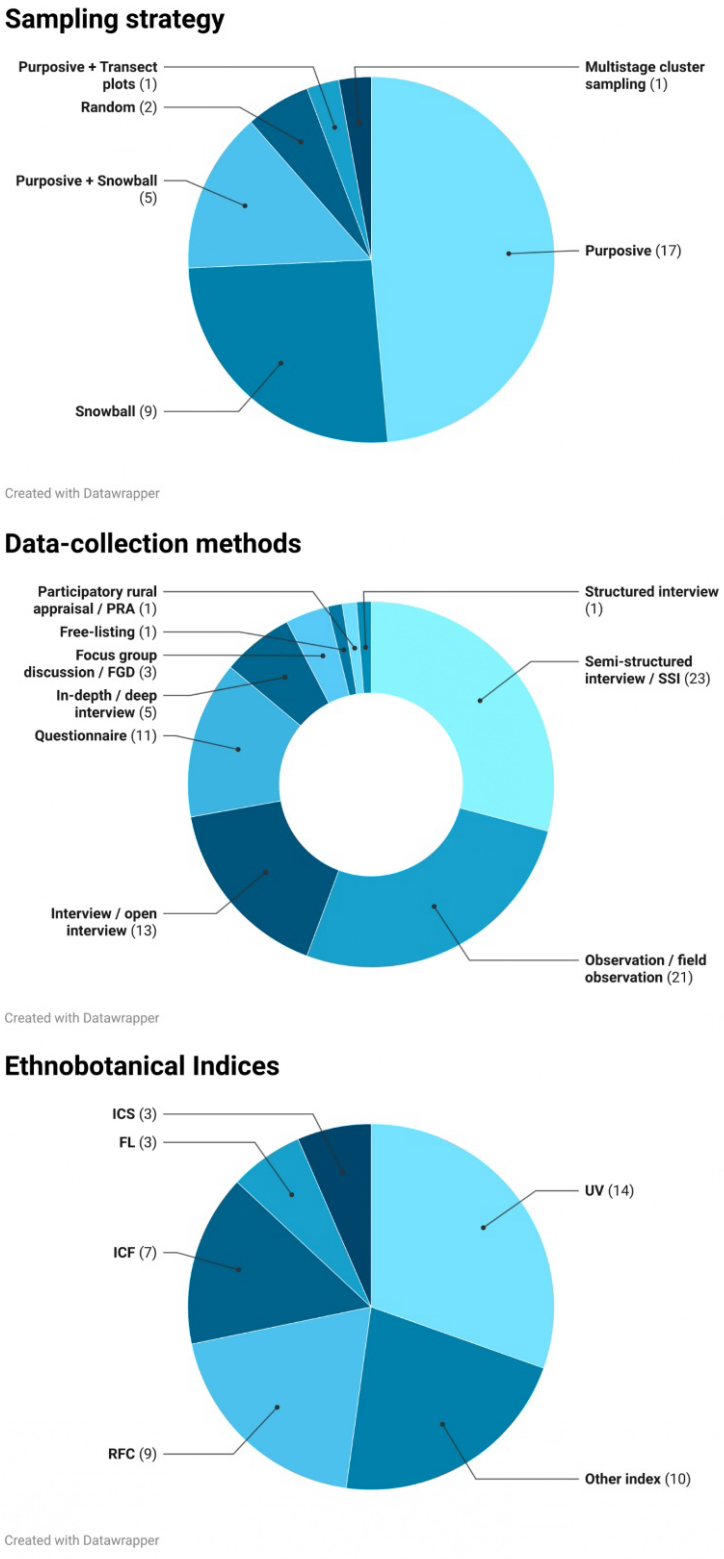


Figure 2. Overview of the included studies

Methodological reporting characteristic

Substantial variation was observed in methodological reporting across the included studies (Table 3). An ethics-related statement was explicitly reported in only five studies. In contrast, a consent procedure was reported in 26 studies (explicit in 21 and implied in five), and a taxonomic identification method was described in 31. Herbarium name or acronym was reported in 12 studies, whereas explicit voucher-specimen documentation was identified in only one study. Quantitative ethnobotanical indices were reported in 21 studies. These findings indicate that participant consent was relatively frequently acknowledged, but formal ethics reporting, voucher documentation, and herbarium-based taxonomic traceability remained limited. The study-level methodological reporting profile is provided in Supplementary File 3.

Table 3. Summary of methodological reporting domains

Reporting domain	Studies (n)
Ethics-related statement reported	5
Consent procedure reported	26 (explicit 21; implied 5)
Taxonomic identification method described	31
Herbarium name/acronym reported	12
Voucher specimen explicitly mentioned	1
Quantitative ethnobotanical indices reported	21
Site/community permission	1

Based on the five scored domains (ethics approval, consent procedure, taxonomic identification method, herbarium name/acronym, and quantitative indices), 22 studies (61.11%) showed moderate completeness, nine (25.00%) high completeness, and five (13.89%) low completeness (Figure 3, Supplementary File 3). High scores were driven mainly by the frequently reported consent, identification-method, and index domains: only four of the nine high-scoring studies reported ethics approval, and none reported a voucher specimen. A high score therefore indicates relatively complete methodological description, not specimen-level botanical traceability.

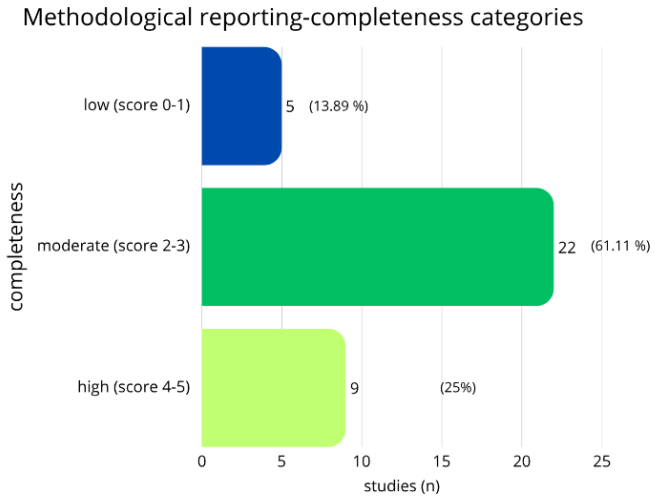


Figure 3. Methodological reporting-completeness categories among the 36 included studies. One point was assigned for each reported domain (ethics approval, consent procedure, taxonomic identification method, herbarium name/acronym, and quantitative indices); 0-1 = low, 2-3 = moderate, 4-5 = high.

Geographical and cultural distribution of the evidence base

The included studies covered 18 provinces concentrated in western and central Indonesia (Figure 4). Java was the most represented island (11 studies), followed by Sumatra (9), Kalimantan/Borneo (7), Bali (3), and Sulawesi (2), with single studies from Sumbawa, Bangka, Lombok, and Madura. At the provincial level, Central Java contributed the most studies (5), followed by North Sumatra (4) and by Bali, East Java, West Java, and West Kalimantan (3 each). Twenty-seven studies were conducted in rural settings only, whereas urban, peri-urban, or mixed settings were represented by nine studies. The current evidence base therefore mainly reflects rural community knowledge and remains geographically imbalanced, with no included study from Maluku or Papua and limited representation of urbanizing populations.

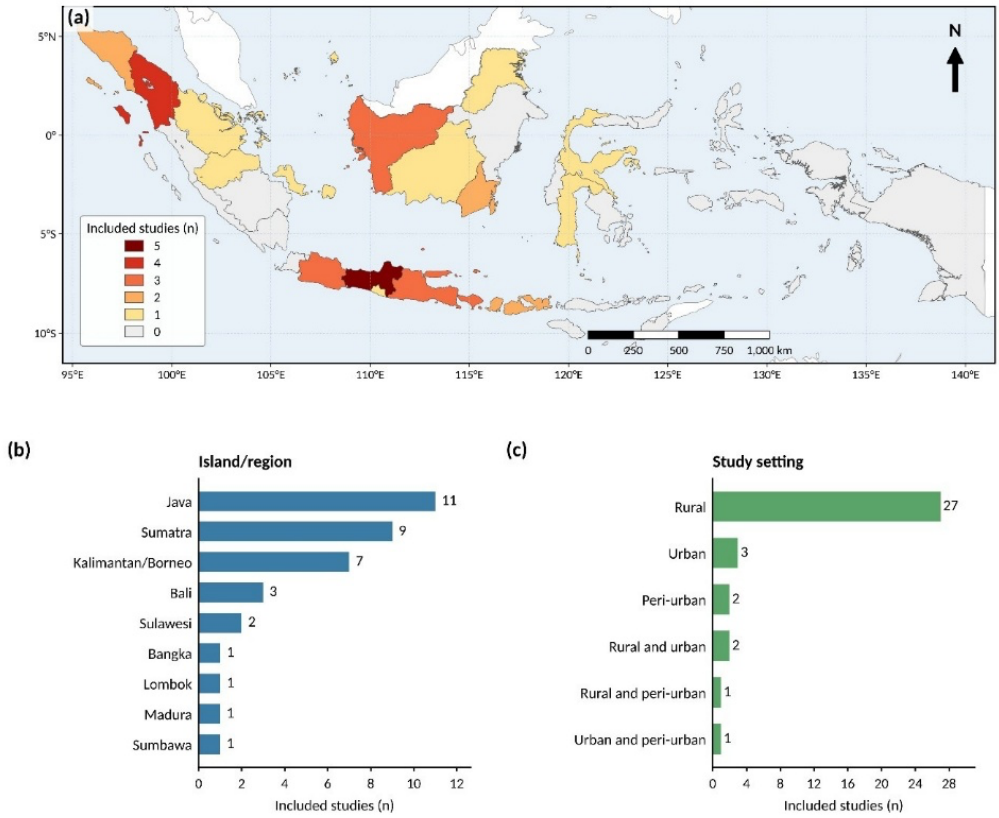


Figure 4. Geographic distribution of the 36 included ethnobotanical studies by (a) province, (b) island/region, and (c) study setting. In (a), shading indicates the number of included studies per province; boundaries follow the 34-province configuration in use before the 2022 division of Papua, from which no included study originated (projection: World Mercator, EPSG:3395).

Plant diversity and cross-study recurrence for diabetes-related conditions

The 36 included studies documented 202 use-reports, covering 121 distinct binomials and 115 taxon entries after consolidating synonyms. The complete inventory, including scientific names, vernacular names, families, plant parts, preparations, and routes of administration, is provided in Supplementary File 4. Recurrence across geographical and sociocultural settings is summarized in Figure 5, which shows taxa cited in at least two studies and distinguishes widely documented antidiabetic plants from those reported in isolated ethnobotanical records.

Overall, the distribution of species mentions showed a marked long-tailed pattern. Seventy-seven taxa were reported in a single study, whereas 38 were reported in at least two studies. As shown in Figure 5, *Orthosiphon aristatus* (Blume) Miq. was the most frequently reported species and was also among the most widely distributed across the represented provinces. *Andrographis paniculata* (Burm.f.) Wall. ex Nees showed the second-highest recurrence, followed by *Phaleria macrocarpa* (Scheff.) Boerl. and *Physalis angulata* L. Nine taxa were reported in four studies each: *Annona muricata* L., *Gynura procumbens* (Lour.) Merr., *Leucaena leucocephala* (Lam.) de Wit, *Mimosa pudica* L., *Moringa oleifera* Lam., *Muntingia calabura* L., *Swietenia mahagoni* (L.) Jacq., *Syzygium cumini* (L.) Skeels, and *Syzygium polyanthum* (Wight) Walp. The remaining 25 recurrent taxa, including *Cinnamomum burmanni* (Nees & T.Nees) Blume, *Morinda citrifolia* L., *Phyllanthus niruri* L., *Piper crocatum* Ruiz & Pav., and *Tithonia diversifolia* (Hemsl.) A. Gray, were reported in two or three studies.

The heatmap showed that recurrent-taxon records were unevenly distributed across provinces (Figure 5). Of the 15 provinces with at least one record, West Java had the most records (27), followed by Central Java (20), Aceh (14), North Sumatra (14), and Jambi (11). The remaining provinces had seven or fewer records each, and Central Kalimantan and North Kalimantan had one each. Some taxa were recorded in several provinces. *O. aristatus* and *A. paniculata* were each recorded in seven provinces, and *P. angulata*, *A. muricata*, and *M. pudica* in four each, indicating a broad distribution across studies and localities. Others were restricted to a single province, which are *C. nutans* only in Central Java, *O. basilicum* only in North Sumatra, and *Z. zerumbet* only in West Java. Province counts depend on how many studies were conducted in each province

and how many taxa each study reported, so they describe the geographic breadth of reporting rather than independent regional selection of a plant. For example, the 27 records from West Java came from three studies, whereas the 11 records from Jambi came from a single study.

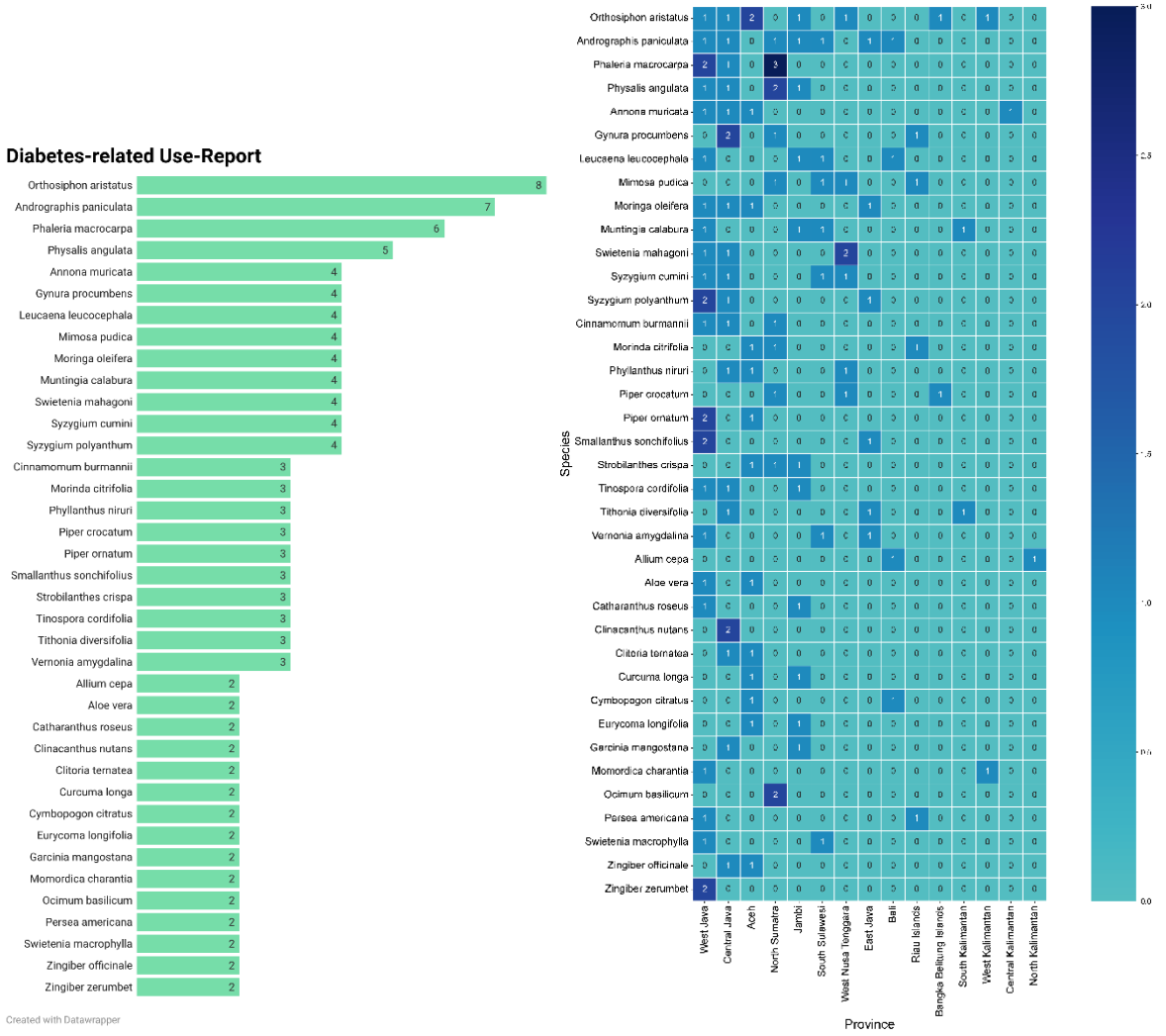


Figure 5. Overview of recurrent medicinal plant species reported for diabetes-related conditions across the most represented provinces in Indonesia

At the family level, medicinal plant use was taxonomically broad rather than concentrated within a narrow group of lineages. The 11 most represented families, namely Asteraceae, Acanthaceae, Lamiaceae, Fabaceae, Zingiberaceae, Myrtaceae, Solanaceae, Meliaceae, Piperaceae, Lauraceae, and Thymelaeaceae, accounted for 118 of the 202 UR (Figure 6). Asteraceae was the most frequently represented family (22 UR), followed by Acanthaceae, Lamiaceae, and Fabaceae (14 UR each). These findings indicate that diabetes-related ethnomedicinal knowledge in Indonesia draws on a taxonomically diverse plant repertoire, while a limited number of recurrent taxa and families contribute disproportionately to the overall evidence base.

Pattern of plant use

Plant-part use was dominated by leaves, which accounted for 67 reports, followed by fruits (19 reports) and bark (14 reports), as shown in Figure 7. Other organs, including stems, roots, seeds, tubers, peel, flowers, whole plants, herb, trunk, resin, bulbs, sap, gel, and rhizomes, were reported less frequently. This pattern indicates that diabetes-related medicinal plant use in Indonesia relies mainly on accessible and renewable plant materials, particularly leaves.

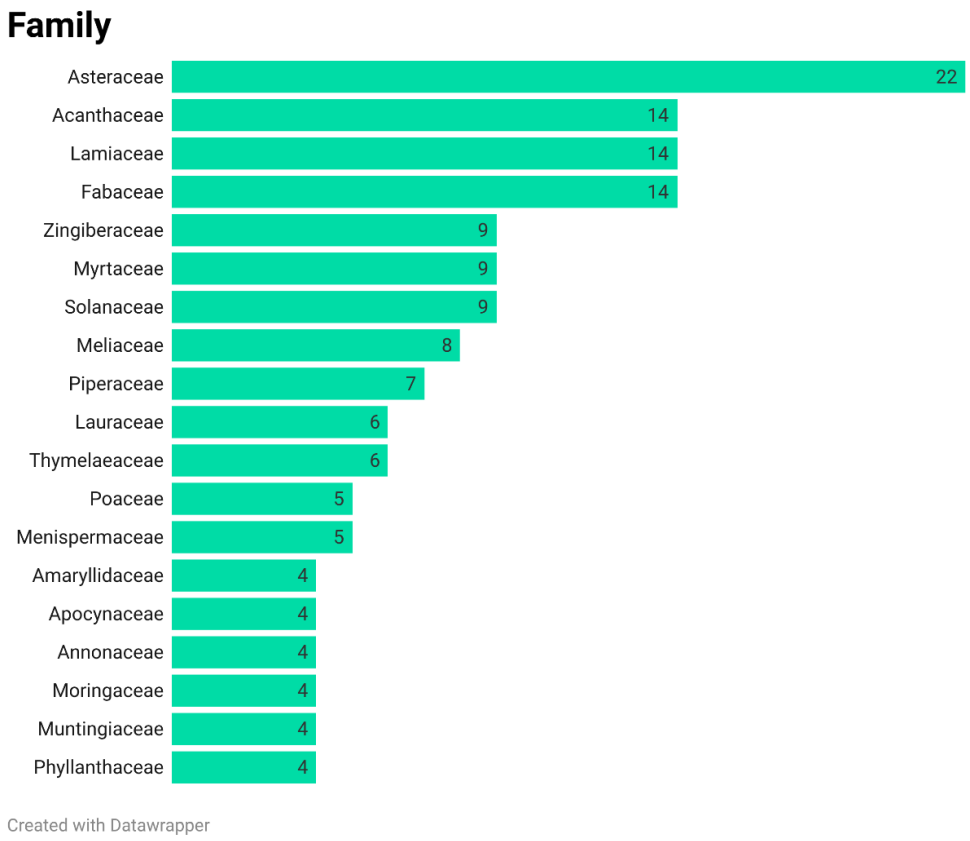


Figure 6. Most represented botanical families among diabetes-related medicinal plant records

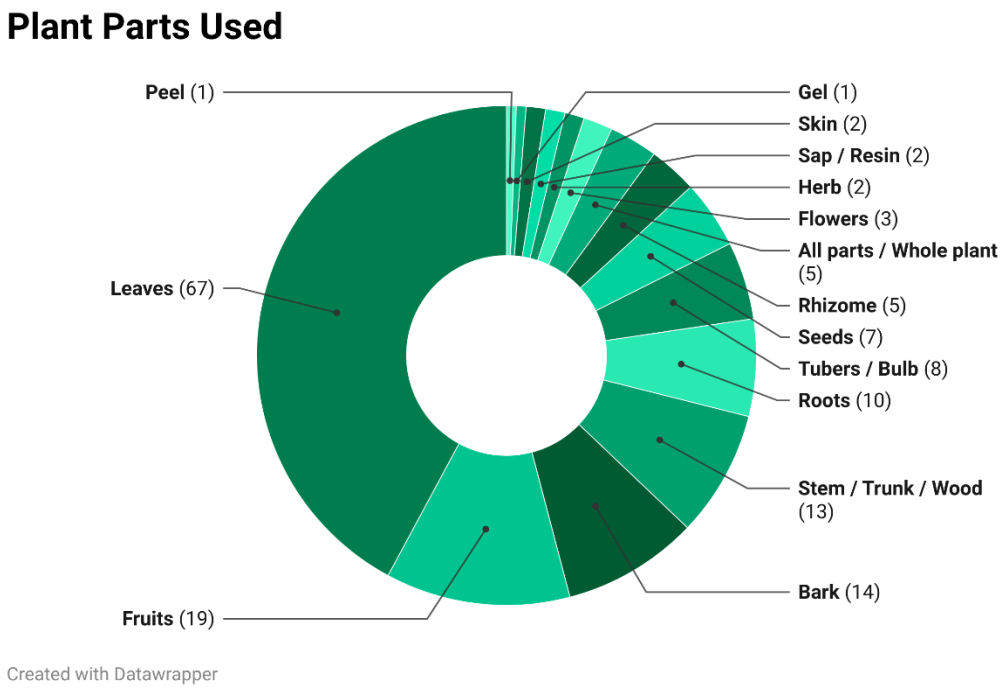


Figure 7. Plant parts used

Preparation methods were dominated by boiling or decoction, which was reported 79 times and represented by far the most common mode of medicinal processing (Figure 8). Other preparation methods were recorded much less frequently, including drink/brewing/wedang (25), juice or pressed extract (11 reports), raw or fresh use (14), crushed or paste preparations (6), dried preparations (10), powder forms (7), and cooked or food-based use (5). Nine entries reported other single-report

methods, and preparation was not reported for 24 entries. This pattern indicates that water-based, low-technology household processing remains the principal method used for preparing medicinal plants for diabetes-related conditions.

Route of administration was highly consistent across the included studies. Of the 102 route records, oral administration accounted for 96, topical application for five, two of which were for diabetic wounds, and dripped administration for one (Figure 8). These findings indicate that medicinal plants used for diabetes-related conditions are administered predominantly as internal remedies, which is consistent with the systemic nature of diabetes management in traditional practice.

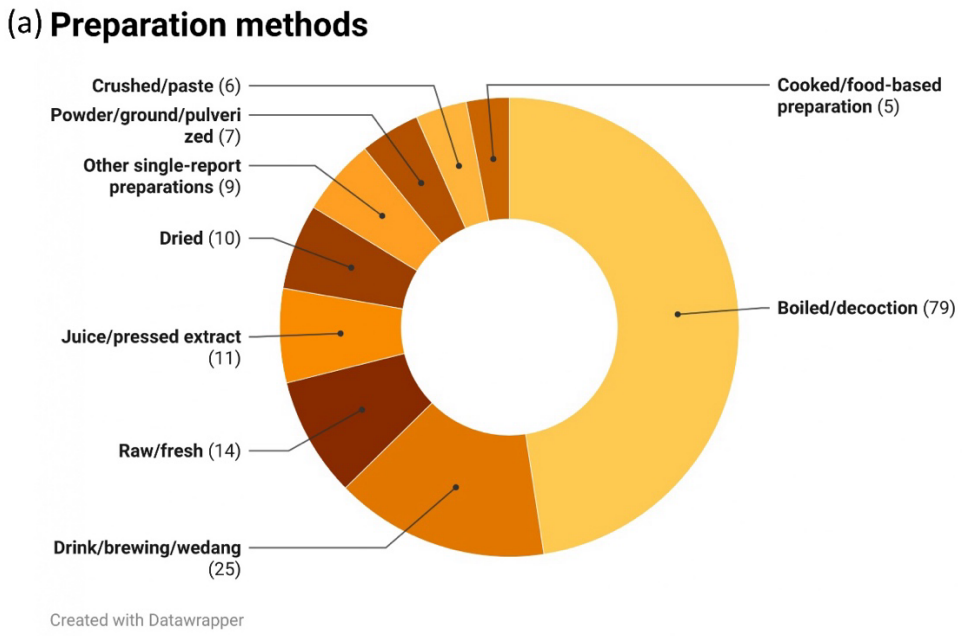


Figure 8. (a) Preparation methods and (b) routes of administration. Totals do not equal the overall number of UR because some entries did not report this information (coded as NR) and some taxa had more than one preparation or route in the primary studies. Values are record frequencies; for routes of administration, n = 102 records.

Conservation relevance of recurrent species

A conservation-status screen was conducted for the recurrent antidiabetic taxa identified in this review. Conservation relevance of recurrent antidiabetic medicinal plants in Indonesia is presented in Table 4 and Table 5.

Table 4. Conservation relevance of recurrent antidiabetic medicinal plants in Indonesia

Species	Family	Recurrent records	Main plant part(s) used	Introduced Status (POWO)	IUCN Red List Status (Global)	CITES Listing
Orthosiphon aristatus (Blume) Miq.	Lamiaceae	8	Leaves, Herb (aerial parts)	Native to Indonesia	Least Concern (LC)	Not listed
Andrographis paniculata (Burm.f.) Wall. ex Nees	Acanthaceae	7	Leaves, Stem, Whole plant	Introduced in Indonesia (native to Indian Subcontinent)	Not Evaluated (NE)	Not listed
Phaleria macrocarpa (Scheff.) Boerl.	Thymelaeaceae	6	Leaves, Bark, Fruit, Seeds	Native to Papua (Indonesia)	Least Concern (LC)	Not listed
Physalis angulata L.	Solanaceae	5	Leaves, Fruit, Whole plant	Introduced in Indonesia (native to tropical America)	Least Concern (LC)	Not listed
Annona muricata L.	Annonaceae	4	Leaves, Skin	Introduced in Indonesia (native to tropical America)	Not Evaluated (NE)	Not listed
Gynura procumbens (Lour.) Merr.	Asteraceae	4	Leaves	Native to Indonesia	Not Evaluated (NE)	Not listed
Leucaena leucocephala (Lam.) de Wit	Fabaceae	4	Bark, Seeds	Introduced in Indonesia (native to Mexico & Central America)	Not Evaluated (NE)	Not listed
Mimosa pudica L.	Fabaceae	4	Leaves, Root	Introduced in Indonesia (native to tropical America)	Least Concern (LC)	Not listed
Moringa oleifera Lam.	Moringaceae	4	Leaves	Introduced in Indonesia (native to India & Pakistan)	Not Evaluated (NE)	Not listed
Muntingia calabura L.	Muntingiaceae	4	Leaves, Fruit	Introduced in Indonesia (native to tropical America)	Not Evaluated (NE)	Not listed
Swietenia mahagoni (L.) Jacq.	Meliaceae	4	Seeds	Introduced in Indonesia (native to Caribbean)	Near Threatened (NT)	Appendix II
Syzygium cumini (L.) Skeels	Myrtaceae	4	Leaves, Bark, Fruit	Native to Indonesia (Java, Lesser Sunda, Maluku, Sulawesi)	Least Concern (LC)	Not listed
Syzygium polyanthum (Wight) Walp.	Myrtaceae	4	Leaves, Sap	Native to Indonesia	Not Evaluated (NE)	Not listed
Cinnamomum burmanni (Nees & T.Nees) Blume	Lauraceae	3	Bark, Skin	Native to Indonesia	Least Concern (LC)	Not listed
Morinda citrifolia L.	Rubiaceae	3	Fruit, Seeds	Native to Indonesia	Least Concern (LC)	Not listed
Phyllanthus niruri L.	Phyllanthaceae	3	Leaves, Stem, Root, Whole plant	Introduced in Indonesia (native to tropical America)	Not Evaluated (NE)	Not listed
Piper crocatum Ruiz & Pav.	Piperaceae	3	Leaves	Introduced in Indonesia (native to Ecuador & Peru)	Not Evaluated (NE)	Not listed
Piper ornatum N.E.Br.	Piperaceae	3	Leaves	Native to Sulawesi	Not Evaluated (NE)	Not listed
Smallanthus sonchifolius (Poepp.) H.Rob.	Asteraceae	3	Leaves	Introduced in Indonesia (native to Bolivia, Colombia, Ecuador, Peru)	Not Evaluated (NE)	Not listed
Strobilanthes crispa (L.) Blume	Acanthaceae	3	Leaves	Native to Indonesia (Java, Lesser Sunda Islands)	Not Evaluated (NE)	Not listed
Tinospora cordifolia (Willd.) Miers	Menispermaceae	3	Leaves, Whole plant	Introduced in Indonesia (native to South Asia)	Not Evaluated (NE)	Not listed

Tithonia diversifolia (Hemsl.) A.Gray	Asteraceae	3	Leaves	Introduced in Indonesia (native to Mexico & Central America)	Not Evaluated (NE)	Not listed
Vernonia amygdalina Delile	Asteraceae	3	Leaves	Introduced in Indonesia	Least Concern (LC)	Not listed
Allium cepa L.	Amaryllidaceae	2	Tubers	Introduced in Indonesia (native to Turkmenistan)	Not Evaluated (NE)	Not listed
Aloe vera (L.) Burm.f.	Asphodelaceae	2	Leaves, Gel	Introduced in Indonesia (native to Oman)	Not Evaluated (NE)	Not listed
Catharanthus roseus (L.) G.Don	Apocynaceae	2	Leaves	Introduced in Indonesia (native to Madagascar)	Not Evaluated (NE)	Not listed
Clinacanthus nutans (Burm.f.) Lindau	Acanthaceae	2	Leaves, Stem	Native to Indonesia	Not Evaluated (NE)	Not listed
Clitoria ternatea L.	Fabaceae	2	Flowers	Introduced in Indonesia	Not Evaluated (NE)	Not listed
Curcuma longa L.	Zingiberaceae	2	Rhizome	Introduced in Indonesia (native to Indian Subcontinent)	Data Deficient (DD)	Not listed
Cymbopogon citratus (DC.) Stapf	Poaceae	2	Stem	Introduced in Indonesia (native to India & Sri Lanka)	Not Evaluated (NE)	Not listed
Eurycoma longifolia Jack	Simaroubaceae	2	Leaves, Root	Native to Indonesia	Least Concern (LC)	Not listed
Garcinia mangostana L.	Clusiaceae	2	Peel	Native to Kalimantan	Data Deficient (DD)	Not listed
Momordica charantia L.	Cucurbitaceae	2	Leaves, Fruit	Native to Indonesia	Not Evaluated (NE)	Not listed
Ocimum basilicum L.	Lamiaceae	2	Leaves	Introduced in Indonesia	Not Evaluated (NE)	Not listed
Persea americana Mill.	Lauraceae	2	Leaves, Seeds	Introduced in Indonesia (native to Mexico & Central America)	Least Concern (LC)	Not listed
Swietenia macrophylla King	Meliaceae	2	Seeds	Introduced in Indonesia (native to Central & South America)	Endangered (EN)	Appendix II
Zingiber officinale Roscoe	Zingiberaceae	2	Rhizome	Introduced in Indonesia	Data Deficient (DD)	Not listed
Zingiber zerumbet (L.) Roscoe ex Sm.	Zingiberaceae	2	Leaves, Rhizome	Native to Kalimantan	Data Deficient (DD)	Not listed

Note: Native or introduced status follows Plants of the World Online (POWO 2026); global conservation status follows the IUCN Red List of Threatened Species (IUCN 2026); CITES listing follows the Checklist of CITES Species (UNEP-WCMC 2026). All databases were accessed between 14 and 20 October 2026. LC = Least Concern; NT = Near Threatened; EN = Endangered; DD = Data Deficient; NE = Not Evaluated.

Table 5. Organ-specific harvesting considerations

Reported organ	**Examples**	**Information required**
Whole plant / all parts	*Andrographis paniculata, Phyllanthus niruri, Physalis angulata*	Source, density, harvest fraction, regeneration.
Roots	*Eurycoma longifolia, Mimosa pudica*	Extent of excavation, plant survival, replacement.
Bark	*Cinnamomum burmanni, Phaleria macrocarpa, Syzygium cumini*	Harvest method, bark recovery, tree condition.
Seeds	*Leucaena leucocephala, Swietenia mahagoni, Swietenia macrophylla, Morinda citrifolia*	Cultivated versus wild source, harvest volume, recruitment.
Leaves	*Gynura procumbens, Orthosiphon aristatus, Tithonia diversifolia*	Harvest frequency, proportion removed, growth response.
Rhizomes / tubers	*Zingiber zerumbet, Curcuma longa, Zingiber officinale, Allium cepa*	Cultivated versus wild source, replanting practice, portion left for regrowth.

Of the 38 recurrent taxa (Table 4), 10 were Least Concern, 4 Data Deficient, and 22 Not Evaluated, indicating that frequent documentation did not coincide with elevated formal extinction risk. Only *Swietenia mahagoni* (Near Threatened) and *Swietenia macrophylla* King (Endangered) had elevated IUCN categories and CITES Appendix II listing, but both are introduced in Indonesia, so these designations reflect global status and trade regulation rather than demonstrated pressure on Indonesian populations. Twenty-four taxa were introduced according to POWO; for species such as *Leucaena leucocephala* and *Tithonia diversifolia*, the relevant issue is invasive-species management rather than collection. Table 5 outlines organ-specific considerations, which are mechanistic only. Collection source and intensity were not extracted, so local impacts cannot be inferred, and future studies should report whether material is wild-collected, cultivated, or market-derived.

Discussion

Earlier Indonesian syntheses compiled broad inventories of antidiabetic or medicinal plants (Arifah *et al.* 2022, Febriyanti *et al.* 2026). The present review does not aim to replace them. It adds a disease-focused dataset in which every taxon is traceable to the primary studies that reported it, describes how recurrence is distributed across studies and provinces, and summarizes reporting completeness by domain and as a 0-5 score, not to rank plants by therapeutic promise. Market surveys can integrate knowledge from several communities, and multiple publications may reflect connected knowledge networks. Provincial breadth is therefore a useful geographical descriptor, not a substitute for culturally attributed records. Availability, cultivation, trade, and knowledge exchange may contribute to repeated documentation, but the present data do not distinguish their causal effects. Similarly, ethnobotanical recurrence does not establish efficacy, a reproducible dose, or clinical safety. Pharmacological work on a recurrent taxon should specify the authenticated species, organ, preparation, and indication rather than extrapolate from a different extract or experimental system.

Recurrence reflects the sampled literature

The 36 included studies yielded 202 use-reports for 115 taxa, and the distribution was strongly long-tailed: 77 taxa were reported in a single study, whereas 38 were reported in at least two. *O. aristatus* was documented most often, followed by *A. paniculata, P. macrocarpa*, and *Physalis angulata*. Several of these taxa also had high citation in the earlier national review (Arifah *et al.* 2022). However, recurrence is a count of publications and not evidence that separate communities independently chose the same plant. Some studies listed several groups; one was a market survey, and publications may draw on connected knowledge networks. Breadth across provinces is therefore a safer descriptor than ethnic labels. *O. aristatus* and *A. paniculata* were each documented in seven provinces, whereas *P. macrocarpa* appeared in six studies but in only three provinces. *O. aristatus* and *A. paniculata* were already embedded in wider Southeast Asian herbal medicine traditions, facilitating diffusion beyond a single ethnic group (Saberi & Chua 2023, Ulfa *et al*. 2025).

The included studies were geographically concentrated in Java, Sumatra, Kalimantan/Borneo, and Bali, with fewer studies from Sulawesi, Sumbawa, Bangka, Lombok, and Madura. Eastern Indonesia, particularly Papua and much of the Maluku region, remained poorly represented. This imbalance limits national inference because Indonesia's ethnolinguistic and ecological diversity is not evenly captured by the current evidence base. Similar geographical disparities in Indonesian ethnobotanical research have been reported previously, with research activity concentrated in Java, Sumatra, and Sulawesi rather than in eastern regions (Sumadijaya *et al.* 2025).

The underrepresentation of eastern Indonesia is important for both scientific and conservation reasons. Papua and adjacent regions contain high biocultural diversity, complex ecological gradients, and extensive traditional knowledge systems, yet logistical constraints, mountainous terrain, island geography, and uneven access to health and research infrastructure may limit field documentation (Saktina & Khoirunnurrofik 2022). Conservation-oriented ethnobotanical studies from South Papua and West Papua indicate that these regions contain distinctive medicinal plant resources and forest-based knowledge systems that require more systematic documentation (Saiba *et al.* 2023, Fahmi *et al.* 2025). Similarly, the limited representation of Nusa Tenggara suggests that dryland and island-based ethnomedicinal systems remain insufficiently characterized (Iswandono *et al.* 2015, Albar *et al.* 2025).

Most included studies were conducted in rural settings, whereas urban and peri-urban ethnobotanical contexts were rarely examined. This pattern is understandable because traditional medicinal plant knowledge is often studied in villages, forest-edge communities, homegardens, and areas where plant gathering remains integrated into daily life (Igustita *et al.* 2023, Rambey *et al.* 2024, Putri *et al.* 2025). However, urban ethnobotany is increasingly relevant in Indonesia, including diabetes-related disease, because traditional remedies are also circulated through markets, household gardens, online trade, and hybrid biomedical-traditional healthcare practices (Rahayu *et al.* 2020, Ulfa *et al*. 2025). The low number of urban and peri-urban studies therefore limits interpretation of how diabetes-related plant use is maintained. Urbanized communities tend

to rely more on introduced plant species, as seen in a study from Mexico, which could lead to a decline in the knowledge and use of local wild medicinal plants (Arjona-García *et al.* 2021). However, urbanization may influence the accessibility and commercialization of these plants. A study in Aceh stated that 47% of diabetes patients used medicinal plants, with cultural norms and accessibility being primary factors (Husna *et al.* 2025).

Repeated documentation may be associated with wide availability in homegardens or markets (Pala *et al.* 2019, Naigaga *et al.* 2021) and with circulation through jamu traditions and trade (Surya *et al.* 2026), but the present data do not distinguish these effects. Recurrence also does not establish efficacy, a reproducible dose, or clinical safety. Because recurrent taxa are often selected later for pharmacological testing or product development (Dixit & Tiwari 2020, Mudau *et al.* 2022, Roman *et al.* 2026), such work should use the authenticated species, plant part, and preparation documented in the field, and should be paired with ethnographic follow-up so that bioactivity is not detached from the conditions of use (Saslis-Lagoudakis *et al.* 2011, Leonti & Casu 2013, Menendez-Baceta *et al.* 2015, Süntar 2020).

Reporting completeness and priorities for future field studies

The elements needed to verify and reuse ethnobotanical records were reported unevenly. Consent procedures were mentioned in 26 of 36 studies (explicit in 21), but formal ethics approval was reported in only five, herbarium names or acronyms in 12, voucher specimens in one, and quantitative indices in 21. These figures describe what was reported, not what was done. A missing statement does not show that approval or consent was absent, and because the review depends on what authors chose to publish, reporting bias is possible.

Ethical-code adherence, site permission, consent, and committee review serve different purposes and should be reported separately. Ethnobotanical research draws on culturally embedded and sometimes restricted knowledge (Aziz *et al*. 2026), and a consent statement alone does not address community permission, benefit sharing, or the governance of local knowledge (Fitzpatrick *et al.* 2016, Albuquerque *et al*. 2025). The International Society of Ethnobiology code is a practical reference for such reporting (Welch 2022).

Botanical traceability was similarly limited. An accepted name in an online database can resolve spelling or synonymy, but it cannot show which specimen an informant used, and a named institution without a specimen identifier is an incomplete route to verification. Voucher specimens provide the reference material for later taxonomic confirmation and pharmacological work (Greene *et al.* 2023, Soejarto *et al.* 2026), and diabetes-focused studies elsewhere illustrate the value of depositing them in institutional herbaria (Umair *et al.* 2017, Ullah *et al.* 2019). These needs are consistent with ConSEFS recommendations for transparent field documentation (Heinrich *et al.* 2018).

Sampling and informant reporting also limit interpretation. Purposive sampling alone was used in 17 studies, and snowball sampling, alone or combined with purposive sampling, in 14. These approaches suit access to knowledgeable informants but introduce selection bias when informants cluster in similar networks (Zrineh *et al.* 2026), and incomplete informant descriptions make records harder to evaluate or return to communities (Bianchi & Gonçalves 2021, Albuquerque *et al.* 2025). Semi-structured interviews (23 studies) and observation (21) predominated, yet the extent of triangulation varied, which makes it difficult to separate verified records from those based on recall (Corroto & Macía 2021, Medley & Kalibo 2005, Vandebroek 2010). Quantitative indices were defined inconsistently, and differing formulas and denominators prevent pooling (Mautone *et al.* 2019, Kohle *et al.* 2021), which is why recurrence was used rather than index values in this review. Future studies should describe sampling and consent, retain indication-specific use statements, report accepted names with authorities, identification methods, herbarium deposition, and voucher numbers, and define every numerator and denominator when indices are used.

Interpretation of plant-use patterns

Leaf use, water-based preparation, and oral administration were common in the extracted inventory, in agreement with patterns described in earlier Indonesian reviews (Arifah *et al.* 2022, Febriyanti *et al.* 2026) and with the general prominence of leaves in herbal remedies (Wahyono *et al*. 2017). Leaf extracts of some recurrent species, such as *A. paniculata* and *G. procumbens*, contain polyphenols and flavonoids that may also contribute to metabolic and hypoglycemic effects (Tahsin *et al*. 2022, Nugraha *et al*. 2025). Decoction method can extract those polar constituents including phenolic acids, tannins, and glycosides, although extraction efficiency varies depending on plant matrix, temperature, particle size, and duration (Perera *et al*. 2017, Sekhon-Loodu & Rupasinghe 2019, Palos-Hernández *et al.* 2024). Boiling may also reduce microbial contamination and certain environmental contaminants, although it may degrade thermolabile compounds in some plants (Ting *et al.* 2013). Preparation was not reported for 24 entries, route information was available for 102 records, and pooled

taxon-level attributes cannot be assumed to apply to every study that cited a taxon. Their recurrence is descriptive rather than proof that these preparations are effective or safe.

Interpretation also depends on what diabetes-related means locally. Records were extracted when articles used terms such as diabetes, hyperglycemia/hyperglycaemia, or blood sugar, so they are translated ethnomedical categories and not identical disease concepts (Rezaei *et al.* 2015, Goyal *et al.* 2023, Grover *et al.* 2025). For example, traders in one market survey grouped diabetes among internal diseases attributed to a sedentary lifestyle and excess sugar and fat (Santhyami *et al.* 2024), and mapping emic categories onto biomedical labels can create interpretive uncertainty (Febriyanti *et al*. 2026). Topical use was rare (five records, two of them for diabetic wounds) and addresses a different complaint from systemic glycaemic control; wound-related effects involve different mechanisms, as in endothelial wound models with *P. angulata* fruit extract (Permatasari *et al.* 2024). Future studies should record the original illness term, whether diagnosis was clinically confirmed, the treated symptom or complication, and the route of administration.

Safety and herb-drug interactions

Recurrence does not establish a safe dose or justify substitution for established diabetes care. Safety depends on the organ, preparation, exposure, and concomitant medicines, and evidence for one part or extract should not be extrapolated to another. This matters for *P. macrocarpa*, for which fruit, leaf, and seed use were pooled in the inventory. Seed extracts have shown cytotoxic activity in experimental assays, which neither establishes clinical poisoning rates nor validates traditional doses (Lay *et al.* 2014). *L. leucocephala* contains mimosine, which has caused toxicity in animals with little human data (Crawford *et al.* 2015, Porto *et al.* 2017, Gotardo *et al.* 2021), so mimosine exposure and the effect of processing need to be characterized before medicinal use is evaluated clinically. Potential herb-drug interactions also require attention. A preclinical study examined the interaction of andrographolide from *A. paniculata* with glipizide (Sundhani *et al.* 2022), and translational use of these taxa is constrained by non-standardized extracts, limited pharmacokinetic profiling, and scarce long-term toxicity data (Nor *et al.* 2025). Such findings cannot quantify risk in patients, but they show why concomitant antidiabetic medication, glycaemic outcomes, and adverse events should be recorded in future human studies. The ethnobotanical records here provide no adequate basis for declaring any listed remedy clinically safe.

Harvesting context and future field priorities

Harvest sensitivity was screened qualitatively from the plant organ reported, separately from formal conservation status. Leaf harvest is generally less destructive when done sustainably (Hernández-Barrios *et al.* 2015), whereas bark removal can reduce tree survival (Nagaike 2020), whole-plant harvest can remove reproductive individuals (Schmidt *et al.* 2011), and seed collection can affect regeneration (Bucharova *et al*. 2025). These are potential mechanisms, not observed population effects in this dataset, and neither frequent publication nor organ type alone justifies designating a conservation priority. Formal threat status was largely uninformative for the recurrent taxa (IUCN-SSC 2023).

Only the two *Swietenia* species combined an elevated IUCN category with CITES Appendix II listing, and because both are introduced in Indonesia, this concern reflects global status and trade regulation, not demonstrated pressure on wild Indonesian populations. Some recurrent taxa are also introduced and sometimes invasive, such as *Leucaena leucocephala* and *Tithonia diversifolia*, for which ecological management is the relevant question (Sharma *et al.* 2022, Zheng *et al.* 2026). The collection source was not extracted. Future studies should state whether material was wild-collected, cultivated, purchased, or gathered from naturalized populations, with the locality and intensity of harvest (Igustita *et al.* 2023). Market surveys can supply part of this information, as one reported that most traded material was cultivated, but only at market level and not per species (Santhyami *et al.* 2024).

The conservation relevance of traditional diabetes-related medicine must be assessed as a complex biocultural issue, where ecological impacts depend not only on IUCN or CITES status, but also on harvesting methods and social dynamics. Studies in South and Southeast Asia, such as research on the vulnerability of intergenerational knowledge in Pakistan (Aziz *et al*. 2026) and community-based conservation in Thailand (Saensouk *et al*. 2025), have explicitly linked ethnobotanical knowledge to cultural sustainability. This review, in the same context, suggests that knowledge of diabetes-related medicinal plants in Indonesia is not only a pharmacological resource but also part of a wider cultural and ecological system, which warrants further documentation, ethical management, and assessment of harvesting sustainability (Hartono *et al*. 2026).

Strength and limitations

This review links a disease-focused inventory to individual primary studies, retains original taxonomic labels, separates analytical denominators, and summarizes recurrence at the use-report level. International and Indonesian databases were

searched under a PICOS-guided framework, and the use-report unit allowed heterogeneous studies to be summarized consistently. Only published, extractable field studies from 2015 to the final search date (14 October 2026) were included. The query was deliberately broad to avoid missing multi-ailment floristic inventories, but open-access, free-full-text, and accredited-journal filters may have excluded paywalled articles, and database coverage and indexing may have limited retrieval. Publication and language bias are possible (33 studies in English, three in Indonesian). Because the core patterns overlap with the earlier national review (Arifah *et al.* 2022), they are largely confirmatory, and the added value lies in traceability, use-report-level recurrence, and the reporting profile.

The data depend on primary reporting. Local illness categories and definitions of diabetes-related conditions were heterogeneous, several botanical identities remain unresolved, and taxon totals should not be equated with an authenticated flora. Multigroup records were not consistently attributable by ethnicity, and overlapping informant populations could not be excluded. The recurrence counts do not account for these dependencies, and residual misclassification during extraction remains possible. Finally, this review cannot establish clinical effectiveness, adverse-event incidence, or population-level harvesting impact.

Conclusion

This systematic review synthesized 36 ethnobotanical studies reporting plants used for diabetes-related conditions in Indonesia, yielding 202 use-reports that involved 121 distinct binomials and 115 taxon entries after consolidating synonyms, across 51 families. Most taxa were reported in a single study, whereas a smaller recurrent group, led by *Orthosiphon aristatus* (Blume) Miq., *Andrographis paniculata* (Burm.f.) Wall. ex Nees, *Phaleria macrocarpa* (Scheff.) Boerl., and *Physalis angulata* L., was documented across several studies and provinces. The recurrent set therefore reflects the sampled literature, shaped by where and how studies were conducted, and does not indicate efficacy or a national ranking of plant importance. Reporting completeness was uneven. Consent procedures were commonly mentioned, but formal ethics approval, herbarium deposition, voucher specimens, and standardized indices were inconsistently reported, which limits taxonomic traceability and cross-study comparison. Harvest-sensitive plant parts and safety concerns were noted for some recurrent taxa and require case-by-case assessment, but this review does not support clinical treatment recommendations. Future studies should extend coverage to eastern Indonesia and urban settings and should report ethical procedures, accepted names with authorities, voucher and herbarium information, explicit use-report definitions, and transparent index formulas. Any pharmacological follow-up should use the authenticated species, plant part, and preparation documented in the field.

Declarations

List of abbreviations: BKPK - Badan Kebijakan Pembangunan Kesehatan (Health Development Policy Agency); BPS - Badan Pusat Statistik (Central Bureau of Statistics); CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora; DM - Diabetes Mellitus; FGD - Focus Group Discussion; FPIC - Free, Prior, and Informed Consent; IUCN - International Union for Conservation of Nature; LPDP - Lembaga Pengelola Dana Pendidikan (Indonesian Endowment Fund for Education); NR - Not Reported; PICOS - Population, Intervention, Comparator, Outcomes, and Study design; POWO - Plants of the World Online; PRA - Participatory Rural Appraisal; PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RISTOJA - Riset Tumbuhan Obat dan Jamu (Research on Medicinal Plants and Herbal Medicine); SSI - Semi-Structured Interview; UNEP-WCMC - United Nations Environment Programme World Conservation Monitoring Centre; UR - Use-Report; UV - Use Value; WHO - World Health Organization

Ethics approval and consent to participate: This study does not require ethical clearance as it is based on a literature review.

Consent for publication: Not applicable.

Availability of data and materials: All data generated or analyzed during this systematic review are included in this article and its supplementary information files. This review used data extracted from previously published sources and did not generate individual-level human participant data.

Competing interests: The authors declare that they have no competing interests that may have inappropriately influenced them in writing this review. The funder had no role in study design, data collection, analysis, interpretation, manuscript preparation, or decision to submit.

Funding: This study is funded by Universitas Padjadjaran through the Indonesian Endowment Fund for Education (LPDP) on behalf of the Indonesian Ministry of Higher Education, Science and Technology and managed under the EQUITY Program (Contract No. 4303/B3/DT.03.08/2025 and 3927/UN6.RKT/HK.07.00/2025) through scheme RMMP awarded to AD (contract number 4024/UN6.3.1/PT.00/2025).

Author contributions: S.P.Q. - Investigation, Data curation, Formal analysis, Writing original draft; R.M.F. - Conceptualization, Methodology, Validation, Formal analysis, Writing review & editing; S.M., Y.R., M.A., and S.B. - Supervision; A.D. - Supervision, Funding acquisition.

Acknowledgements

We would like to thank Universitas Padjadjaran through the Indonesian Endowment Fund for Education (LPDP), on behalf of the Indonesian Ministry of Higher Education, Science and Technology, and managed under the EQUITY Program, who supported and funded this review.

Literature cited

Agustina N, Hutauruk TJW, Sulistyaningrum N, Yudhanto SM, Liza N, Kusumaningrum L, Sugiyarto, Yasa A, Saensouk S, Naim DMd, Setyawan AD. 2022. Diversity of the medicinal plant in homegarden of local communities in the coastal area of Prigi Bay, Trenggalek, East Java, Indonesia. Biodiversitas 23:6302-6312. doi: 10.13057/biodiv/d231226

Albar H, Juhriah, Santosa S. 2025. Ethnobotany of medicinal plants by the community in Langgudu Sub-district, Bima District, West Nusa Tenggara, Indonesia. Biodiversitas 26:315-325. doi: 10.13057/biodiv/d260131

Albuquerque UP, Alves RRN, Ferreira Júnior WS. 2025. The contemporary challenge for ethical research involving the knowledge of indigenous peoples and local communities and afro-descendants and other marginalized, minority, or minoritized groups. Journal of Ethnobiology and Ethnomedicine 21:29. doi: 10.1186/s13002-025-00774-4

Andika ME, Navia ZI, Sari MS. 2025. Kajian etnobotani tumbuhan obat untuk diabetes pada masyarakat Desa Asam Peutik, Langsa, Indonesia. Tengkawang: Jurnal Ilmu Kehutanan 15:186-194.

Andila PS, Tirta IG, Warseno T, Sutomo. 2023. Medicinal plants diversity used by Balinese in Buleleng Regency, Bali. Journal of Tropical Biodiversity and Biotechnology 8:1-18. doi: 10.22146/jtbb.73303

Arifah FH, Nugroho AE, Rohman A, Sujarwo W. 2022. A review of medicinal plants for the treatment of diabetes mellitus: The case of Indonesia. South African Journal of Botany 149:537-558. doi: 10.1016/j.sajb.2022.06.042

Arjona-García C, Blancas J, Beltrán-Rodríguez L, López Binnqüist C, Colín Bahena H, Moreno-Calles AI, Sierra-Huelsz JA, López-Medellín X. 2021. How does urbanization affect perceptions and traditional knowledge of medicinal plants? Journal of Ethnobiology and Ethnomedicine 17:48. doi: 10.1186/s13002-021-00473-w

Asra R, Maryani AT, Yelianti U, Fijridiyanto IA, Adriadi A, Wibowo CAP, Saputri VA, Febrianti A. 2025. Diversity and cultural significance of medicinal plants among multiethnic communities in Jambi Province, Indonesia. Biodiversitas 26(10):5023-5039. doi: 10.13057/biodiv/d261018

Aziz MA, Malik A, Hasan M, Abidullah S, Ullah A, Ullah Z, Abbasi AM, Pieroni A. 2026. Displacement threatens local knowledge: plant foraging in a cross-cultural context in the Gomal area, NW Pakistan. Journal of Ethnobiology and Ethnomedicine 22:12. doi: 10.1186/s13002-026-00852-1

Banerjee S. 2024. Introduction to ethnobotany and traditional medicine. In: Das Talukdar A, Patra JK, Das G, Nath D. (eds). Traditional resources and tools for modern drug discovery. Springer Nature Singapore, Singapore, Pp. 1-30. doi: 10.1007/978-981-97-4600-2_1

Bianchi FM, Gonçalves LT. 2021. Getting science priorities straight: how to increase the reliability of specimen identification? Biology Letters 17:20200874. doi: 10.1098/rsbl.2020.0874

BPS. 2011. Kewarganegaraan, suku bangsa, agama, dan bahasa sehari-hari penduduk Indonesia. Badan Pusat Statistik, Jakarta, Indonesia. Report 04000.1110.

BPS. 2025. Statistical yearbook of Indonesia 2025. Badan Pusat Statistik, Jakarta, Indonesia. Report 03200.25004.

Bucharova A, Bossdorf O, Scheepens JF, Salguero-Gómez R. 2025. Assessing limits of sustainable seed harvest in wild plant populations. Conservation Biology 39:e70075. doi: 10.1111/cobi.70075

Corroto F, Macía MJ. 2021. What is the most efficient methodology for gathering ethnobotanical data and for participant selection? Medicinal plants as a case study in the Peruvian Andes. Economic Botany 75:63-75. doi: 10.1007/s12231-021-09514-7

Crawford G, Puschner B, Affolter V, Stalis I, Davidson A, Baker T, Tahara J, Jolly A, Ostapak S. 2015. Systemic effects of *Leucaena leucocephala* ingestion on ringtailed lemurs (*Lemur catta*) at Berenty Reserve, Madagascar. American Journal of Primatology 77:633-641. doi: 10.1002/ajp.22386

Darmastuti SA, Nazar IA, Setyawan AD. 2024. Plant diversity and its use in Javanese urban home garden: An ethnobotanical study in Central Java, Indonesia. Asian Journal of Ethnobiology 7:32-42. doi: 10.13057/asianjethnobiol/y070104

Dewi TM, Sumarni W, Handayani L, Muhiri. 2024. Ethnobotany of traditional medicine in Akit Tribe, Teluk Setimbul Village, Karimun District, Indonesia. Biodiversitas 25:2696-2704. doi: 10.13057/biodiv/d250842

Dixit S, Tiwari S. 2020. Investigation of anti-diabetic plants used among the ethnic communities of Kanpur division, India. Journal of Ethnopharmacology 253:112639. doi: 10.1016/j.jep.2020.112639

Fahmi MS, Rado RH, Klau RG, Majid I. 2025. Preserving ethnobotany in Wasur National Park South Papua through intellectual property rights protection. IOP Conference Series: Earth and Environmental Science 1471:012055. doi: 10.1088/1755-1315/1471/1/012055

Fathurrahman F, Nursanto J, Madjid A, Ramadanil R. 2016. Ethnobotanical study of "Kaili Inde" tribe in Central Sulawesi Indonesia. Emirates Journal of Food and Agriculture 28:337-347. doi: 10.9755/ejfa.2015-06-463

Febriyanti RM, Indradi RB, Maisyarah IT, Iskandar Y, Susanti RD, Lestari D. 2025. Alpha-amylase and alpha-glucosidase enzymes inhibition and antioxidant potential of selected medicinal plants used as anti-diabetes by Sundanese community in West Java, Indonesia. BMC Complementary Medicine and Therapies 25:426. doi: 10.1186/s12906-025-05144-x

Febriyanti RM, Ramadhania ZM, Tjitraresmi A, Indradi RB, Maisyarah IT, Maundu PM, Muhaimin M, Sujarwo W. 2026. A systematic review of ethnobotanical study in Indonesia: diversity and cultural patterns of medicinal plant use. Journal of Ethnobiology and Ethnomedicine 22:42. doi: 10.1186/s13002-026-00879-4

Febriyanti RM, Slikkerveer LJ, Spaink HP, Lestari K, Saefullah K. 2022. Ethnomedicinal study of Ubar Kampung for diabetes mellitus: Indigenous knowledge, belief, and practice of medicinal, aromatic, and cosmetic (MAC) plants in Sunda Region, West Java, Indonesia. International Journal of Applied Pharmaceutics 14(Suppl 5):148-153. doi: 10.22159/ijap.2022.v14s5.31

Fitzpatrick EFM, Martiniuk ALC, D'Antoine H, Oscar J, Carter M, Elliott EJ. 2016. Seeking consent for research with indigenous communities: a systematic review. BMC Medical Ethics 17:65. doi: 10.1186/s12910-016-0139-8

Gotardo AT, Dipe VV, Almeida ERMD, Hueza IM, Pfister JA, Górniak SL. 2021. Potential toxic effects produced by L-mimosine in the thyroid and reproductive systems. Evaluation in male rats. Toxicon 203:121-128. doi: 10.1016/j.toxicon.2021.10.003

Goyal R, Singhal M, Jialal I. 2023. Type 2 diabetes. StatPearls Publishing, Treasure Island, FL, USA. https://www.ncbi.nlm.nih.gov/books/NBK513253/ (Accessed 01/01/2026).

Greene AM, Teixidor-Toneu I, Odonne G. 2023. To pick or not to pick: Photographic voucher specimens as an alternative method to botanical collecting in ethnobotany. Journal of Ethnobiology 43:44-56. doi: 10.1177/02780771231162190

Grover R, Mittal V, Sharma A. 2025. Herbal remedies for type 2 diabetes mellitus: An explicit review. Current Drug Therapy 20:1034-1052. doi: 10.2174/0115748855307512240802043813

Hartono A, Indriaty, Suwardi AB, Sari N, Nugroho W, Ladisa S, Rasuna A, Fauziani. 2026. Ethnobotany of the Alas Tribe, Indonesia, a taxonomic family-based analysis of plant use and cultural significance. Asian Journal of Ethnobiology 9(1):1-9. doi: 10.13057/asianjethnobiol/y090108

Heinrich M, Lardos A, Leonti M, Weckerle C, Willcox M, Applequist W, Ladio A, Lin Long C, Mukherjee P, Stafford G. 2018. Best practice in research: Consensus statement on ethnopharmacological field studies - ConSEFS. Journal of Ethnopharmacology 211:329-339. doi: 10.1016/j.jep.2017.08.015

Henri, Sari DP, Hakim L. 2022. Medicinal plants for traditional treatment used by the Malays in South Bangka Regency, Indonesia. Biosaintifika 14:125-134. doi: 10.15294/biosaintifika.v14i1.34455

Hernández-Barrios JC, Anten NPR, Martínez-Ramos M. 2015. Sustainable harvesting of non-timber forest products based on ecological and economic criteria. Journal of Applied Ecology 52:389-401. doi: 10.1111/1365-2664.12384

Husaini IPA, Maulany RI, Nasri N, Ngakan PO. 2022. Diversity and use of traditional medicinal plant species in Bantimurung-Bulusaraung National Park, Indonesia. Biodiversitas 23:5539-5550. doi: 10.13057/biodiv/d231101

Husna F, Marisa M, Suryawati S, Suyatna FD, Husnah H, Hakim RW, Aulia MI, Dasopang EA. 2025. Traditional remedies from Aceh for diabetes mellitus treatment: Patterns of use in rural-urban areas in Aceh. Clinical Epidemiology and Global Health 34:102079. doi: 10.1016/j.cegh.2025.102079

IDF. 2025. IDF diabetes atlas, 11th edition. International Diabetes Federation, Brussels, Belgium. https://diabetesatlas.org/resources/idf-diabetes-atlas-2025/ (Accessed 21/11/2025).

Igustita, Fatikha LA, Astikasari L, Kusuma D, Nugraheni RS, Muryanto BS, Anshory DA, Hidayat S, Sujarta P, Yasa A, Naim DM, Setyawan AD. 2023. Ethnobotany of medicinal plants in homegarden of Menoreh Karst Area, Purworejo District, Indonesia. Asian Journal of Ethnobiology 6:171-181. doi: 10.13057/asianjethnobiol/y060208

Iswandono E, Muhammad Zuhud EA, Hikmat A, Kosmaryandi N. 2015. The ethnobotany knowledge of Manggarai tribe and the implication utilization of forest plants in the mountains of Ruteng. Jurnal Ilmu Pertanian Indonesia 20:171-181. doi: 10.18343/jipi.20.3.171

IUCN. 2026. The IUCN Red List of Threatened Species. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland. https://www.iucnredlist.org (Accessed 14-20/10/2026).

IUCN-SSC. 2023. 2023 report of the IUCN Species Survival Commission and Secretariat. Stand-alone report IUCN SSC Indonesian Plant Red List Authority. https://iucn.org/sites/default/files/2024-09/2023-iucn-ssc-indonesian-plant-rla-report_publication.pdf (Accessed 14/10/2026).

Julung H, Supiandi MI, Ege B, Zubaidah S, Mahanal S. 2023. Ethnobotany of medicinal plants in the Dayak Linoh Tribe in Sintang District, Indonesia. Biodiversitas 24:767-775. doi: 10.13057/biodiv/d240212

Kemenkes BKPK. 2023. Survei Kesehatan Indonesia (SKI) dalam angka: data akurat kebijakan tepat. Badan Kebijakan Pembangunan Kesehatan, Kementerian Kesehatan, Jakarta, Indonesia.

Khusna UN, Jumari J, Prihastanti E. 2023. Ethnobotany of medicinal plants in the Jalawastu Cultural Village Community, Brebes, Central Java, Indonesia. Egyptian Journal of Botany 63:457-474. doi: 10.21608/ejbo.2022.166112.2156

Kohle R, Gurav A, Prasad GP, Rath C, Mangal A, Srikanth N. 2021. Influence of Ayurveda in traditional health practice of tribe of Shahapur and Jawhar forest area of Maharashtra. Ethnobotany Research and Applications 22:1-36. doi: 10.32859/era.22.19.1-36

Latifah S, Fachrudin KA. 2024. Ethnobotanical study of efficacious plants in urban communities. IOP Conference Series: Earth and Environmental Science 1352:012104. doi: 10.1088/1755-1315/1352/1/012104

Lay MM, Karsani SA, Banisalam B, Mohajer S, Abd Malek SN. 2014. Antioxidants, phytochemicals, and cytotoxicity studies on *Phaleria macrocarpa* (Scheff.) Boerl seeds. BioMed Research International 2014:1-13. doi: 10.1155/2014/410184

Leonti M, Casu L. 2013. Traditional medicines and globalization: current and future perspectives in ethnopharmacology. Frontiers in Pharmacology 4:92. doi: 10.3389/fphar.2013.00092

Malik AK, Redhu A, Mohiuddin I, Philippe SK. 2026. Exploring the pharmacological evaluation of Indian medicinal herbs for managing diabetes. Current Analytical Chemistry 22:610-626. doi: 10.2174/0115734110343503250217080253

Mautone M, De Martino L, De Feo V. 2019. Ethnobotanical research in Cava de' Tirreni area, Southern Italy. Journal of Ethnobiology and Ethnomedicine 15:50. doi: 10.1186/s13002-019-0330-3

Medley KE, Kalibo HW. 2005. An ecological framework for participatory ethnobotanical research at Mt. Kasigau, Kenya. Field Methods 17:302-314. doi: 10.1177/1525822X05277462

Menendez-Baceta G, Aceituno-Mata L, Reyes-García V, Tardío J, Salpeteur M, Pardo-de-Santayana M. 2015. The importance of cultural factors in the distribution of medicinal plant knowledge: A case study in four Basque regions. Journal of Ethnopharmacology 161:116-127. doi: 10.1016/j.jep.2014.12.007

Milad M, Fauji F, Yulianti R, Dwiastuti R, Tanduh Y. 2023. Ethnobotanical study of medicinal plants in Natai Sedawak village, Sukamara Regency, Central Kalimantan, Indonesia. Plant Science Today 10:1-4. doi: 10.14719/pst.1895

Mudau TE, Olowoyo JO, Amoo SO. 2022. Ethnobotanical assessment of medicinal plants used traditionally for treating diabetes in Vhembe district, Limpopo Province, South Africa. South African Journal of Botany 146:304-324. doi: 10.1016/j.sajb.2021.10.016

Murtey MD, Vanoh D. 2025. Health benefits from medicinal plants. In: Lahiri D, Nag M, Bhattacharya D, Pati S, Sarkar T. (eds). Bioactive ingredients for healthcare industry volume 1. Springer Nature Singapore, Singapore, Pp. 325-346. doi: 10.1007/978-981-96-3663-1_15

Nagaike T. 2020. Effects of heavy, repeated bark stripping by *Cervus nippon* on survival of *Abies veitchii* in a subalpine coniferous forest in central Japan. Journal of Forest Research 31:1139-1145. doi: 10.1007/s11676-019-00940-x

Nahdi MS, Martiwi INA, Arsyah DC. 2016. The ethnobotany of medicinal plants in supporting family health in Turgo, Yogyakarta, Indonesia. Biodiversitas 17:900-906. doi: 10.13057/biodiv/d170268

Naigaga H, Ssekandi J, Ngom A, Sseremba G, Mbaye MS, Noba K. 2021. Ethnobotanical knowledge of home garden plant species and its effect on home garden plant diversity in Thies region of Senegal. Environment, Development and Sustainability 23:7524-7536. doi: 10.1007/s10668-020-00930-8

Naveen YP, Urooj A, Byrappa K. 2021. A review on medicinal plants evaluated for anti-diabetic potential in clinical trials: Present status and future perspective. Journal of Herbal Medicine 28:100436. doi: 10.1016/j.hermed.2021.100436

Nor NHM, Jaffar FHF, Kashim MIAM, Mokhtar MH. 2025. Antidiabetic potential of *Gynura procumbens* (Lour.) Merr.: a review of in vitro and in vivo studies. Frontiers in Pharmacology 16:1646591. doi: 10.3389/fphar.2025.1646591

Nugraha AS, Kintoko K, Putri CPZS, Az-Zahra F, Firli LN, Rani DM, Purnomo YD, Nguyen PTV, Puspitasari RM, Hartati T, Triatmoko B, Pratama ANW, Wahyuni DSC, Muliasari H, Keller PA, Wangchuk P. 2025. Antidiabetic medicinal plants of

Indonesia: their in silico, in vitro, in vivo and clinical trial studies. Phytochemistry Reviews 25:1581-1619. doi: 10.1007/s11101-025-10173-y

Nuraeni E, Alkandahri M, Tanuwidjaja SM, Fadhilah KN, Kurnia GS, Indah D, Permana A, Hasanah A, Ahmad F, Barkah DC, Ningsih SNR, Khoerunnisa A, Putri DIS, Damayanti TA, Aisyah D, Aeni FN. 2022. Ethnopharmacological study of medicinal plants in the Rawamerta Region Karawang, West Java, Indonesia. Open Access Macedonian Journal of Medical Sciences 10(A):1560-1564. doi: 10.3889/oamjms.2022.10939

Nurotuljannah N, Syamswisna S, Fajri H. 2024. Etnobotani tumbuhan obat di Desa Sungai Dungun Kabupaten Mempawah, Kalimantan Barat, Indonesia. Jambura Edu Biosfer Journal 6(1):21-30. doi: 10.34312/jebj.v6i1.20986

Nursamsu, Nuraini, Sarjani TM, Mardudi. 2024. The use of medicinal plants in the Aneuk Jamee tribe in Kota Bahagia, South Aceh District, Indonesia. Biodiversitas 25:2524-2540. doi: 10.13057/biodiv/d250622

Oktavia GAE, Darma IDP, Sujarwo. 2017. Studi etnobotani tumbuhan obat di kawasan sekitar Danau Buyan-Tamblingan, Bali. Buletin Kebun Raya 20:1-16. doi: 10.14203/bkr.v0i0.235

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D. 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Systematic Reviews 10:89. doi: 10.1186/s13643-021-01626-4

Pala NA, Sarkar BC, Shukla G, Chettri N, Deb S, Bhat JA, Chakravarty S. 2019. Floristic composition and utilization of ethnomedicinal plant species in home gardens of the Eastern Himalaya. Journal of Ethnobiology and Ethnomedicine 15:14. doi: 10.1186/s13002-019-0293-4

Palos-Hernández A, González-Paramás AM, Santos-Buelga C. 2024. Latest advances in green extraction of polyphenols from plants, foods and food by-products. Molecules 30:55. doi: 10.3390/molecules30010055

Perera PRD, Ekanayake S, Ranaweera KKDS. 2017. Antidiabetic compounds in *Syzygium cumini* decoction and ready to serve herbal drink. Evidence-Based Complementary and Alternative Medicine 2017:1083589. doi: 10.1155/2017/1083589

Permatasari N, Rachmawati R, Wiyasa IWA, Larasati MES, Warsan GSA, Gisma RF. 2024. Effects of *Physalis angulata* L. fruit extract on endothelial cell migration and VEGF concentration during wound healing under hyperglycemic conditions: An in vitro study. Tropical Journal of Natural Product Research 8:8303-8306. doi: 10.26538/tjnpr/v8i9.8

Porto MR, Moscardini ARC, Novais EPF, Cabral Filho SLS, Lima EMM, Castro MB. 2017. Intoxicação natural e experimental por *Leucaena leucocephala* em equinos. Pesquisa Veterinária Brasileira 37:829-834. doi: 10.1590/s0100-736x2017000800008

POWO. 2026. Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew, London, United Kingdom. https://powo.science.kew.org (Accessed 14-20/10/2026).

Pratami MP, Anggraeni A, Sujarwo W. 2024. Ethnobotany of medicinal plants in Leuwiliang (Bogor), Indonesia. Ethnobotany Research and Applications 27:1-41. doi: 10.32859/era.27.1.1-41

Purwanti E, Mahmudati N, Faradila SF, Fauzi A. 2020. Utilization of plants as traditional medicine for various diseases: Ethnobotany study in Sumenep, Indonesia. AIP Conference Proceedings 2231(1):040024. doi: 10.1063/5.0002430

Putra ANK, Qotrunnada A, Wahyudin I, Friscilla S, Rahayu SE, Putri AHT. 2023. Ethnobotanical study of medicinal plants for diabetes mellitus in the Sanggabuana Area, Karawang, West Java. Journal of Tropical Biodiversity 4:1-18. doi: 10.59689/bio.v4i1.201

Putri IASLP, Demmallino E, Purwanto Y, Ismail A, Hijjang P, Achmad A, Yahya. 2025. Ethnoecology inheritance among the younger generation in villages around the Maros Pangkep karst. IOP Conference Series: Earth and Environmental Science 1553:012040. doi: 10.1088/1755-1315/1553/1/012040

Putri LSE, Dasumiati, Kristiyanto, Mardiansyah, Malik C, Leuvinadrie LP, Mulyono EA. 2016. Ethnobotanical study of herbal medicine in Ranggawulung Urban Forest, Subang District, West Java, Indonesia. Biodiversitas 17:172-176. doi: 10.13057/biodiv/d170125

Rahayu SM, Andini AS. 2019. Ethnobotanical study on medicinal plants in Sesaot Forest, Narmada, West Lombok, Indonesia. Biosaintifika 11:234-242. doi: 10.15294/biosaintifika.v11i2.19314

Rahayu YYS, Araki T, Rosleine D. 2020. Factors affecting the use of herbal medicines in the universal health coverage system in Indonesia. Journal of Ethnopharmacology 260:112974. doi: 10.1016/j.jep.2020.112974

Rambey R, Lubis ASJ. 2023. Ethnobotany of medicinal plants community in Saroha Village, Tanjung Botung, Barumun District, Padang Lawas Regency, Utara, North Sumatra. Journal of Physics: Conference Series 2421:012008. doi: 10.1088/1742-6596/2421/1/012008

Rambey R, Nelasufa F, Athoriez APM, Solihin, Rahmawaty, Susilowati A, Afifuddin Y. 2024. Ethnobotanical study of medicinal plants by indigenous community of Aek Guo Village, Mandailing Natal District, Indonesia. Biodiversitas 25:1046-1056. doi: 10.13057/biodiv/d250318

Rambey R, Onrizal O. 2022. Ethnobotany of medicinal plants in Asam Jawa Village, South Labuhanbatu, North Sumatra, Indonesia. IOP Conference Series: Earth and Environmental Science 977:012112. doi: 10.1088/1755-1315/977/1/012112

Rezaei A, Farzadfard A, Amirahmadi A, Alemi M, Khademi M. 2015. Diabetes mellitus and its management with medicinal plants: A perspective based on Iranian research. Journal of Ethnopharmacology 175:567-616. doi: 10.1016/j.jep.2015.08.010

Rohman F, Rahyu Lestari S, Hari Utomo D, Purwanto, Juma Y, Nur Arifah S, Annisa Y. 2019. The utilization of plant diversity by Tengger tribe around Bromo Tengger Semeru National Park, East Java, Indonesia. IOP Conference Series: Earth and Environmental Science 276:012042. doi: 10.1088/1755-1315/276/1/012042

Roman WP, Martin HD, Ismail H, Islam MdS. 2026. Medicinal plants used in the Maasai traditional healthcare system for diabetes and associated conditions in Monduli District, Arusha, Tanzania. Scientific African 31:e03165. doi: 10.1016/j.sciaf.2025.e03165

Saberi SEM, Chua LS. 2023. Potential of rosmarinic acid from *Orthosiphon aristatus* extract for inflammatory induced diseases and its mechanisms of action. Life Sciences 333:122170. doi: 10.1016/j.lfs.2023.122170

Saensouk P, Saensouk S, Boonma T, Hanchana K, Rakarcha S, Maknoi C, Chanthavongsa K, Jitpromma T. 2025. Ecological analysis and ethnobotanical evaluation of plants in Khanthararat Public Benefit Forest, Kantarawichai District, Thailand. Forests 16:1012. doi: 10.3390/f16061012

Safitri S, Mulyadi A, Nofrizal, Yoswaty D. 2024. Ecological and potential ethnobotanical characterization of mangrove ecotourism area Sungai Bersejarah, Siak Regency, Riau, Indonesia. International Journal of Sustainable Development and Planning 19:3453-3463. doi: 10.18280/ijsdp.190915

Saiba Y, Ungirwalu A, Murdjoko A, Brearley FQ, Peday MH, Yowei RN, Imburi CS, Runtuboi YY, Djitmau DA, Sa'diyah SH. 2023. Ethnobotany and conservation applications in the Noken making by the Sougb Tribe of West Papua, Indonesia. Biodiversitas 24:4577-4583. doi: 10.13057/biodiv/d240861

Saktina R, Khoirunnurrofik K. 2022. The effect of geographical conditions on the role of the special autonomy fund for the availability of road infrastructure in Papua. Jurnal Bina Praja 14:111-122. doi: 10.21787/jbp.14.2022.111-122

Santhyami, Laraswati, Agustina L, Agustina P. 2024. Exploring urban ethnobotany: A case study of medicinal plants traded in Gede Hardjonagoro Market, Surakarta, Indonesia. Tropical Journal of Natural Product Research 8:6839-6851. doi: 10.26538/tjnpr/v8i4.13

Saslis-Lagoudakis CH, Williamson EM, Savolainen V, Hawkins JA. 2011. Cross-cultural comparison of three medicinal floras and implications for bioprospecting strategies. Journal of Ethnopharmacology 135:476-487. doi: 10.1016/j.jep.2011.03.044

Schmidt IB, Mandle L, Ticktin T, Gaoue OG. 2011. What do matrix population models reveal about the sustainability of non-timber forest product harvest?: Evaluating NTFP harvest sustainability. Journal of Applied Ecology 48:815-826. doi: 10.1111/j.1365-2664.2011.01999.x

Sekhon-Loodu S, Rupasinghe HPV. 2019. Evaluation of antioxidant, antidiabetic and antiobesity potential of selected traditional medicinal plants. Frontiers in Nutrition 6:53. doi: 10.3389/fnut.2019.00053

Sharma P, Kaur A, Batish DR, Kaur S, Chauhan BS. 2022. Critical insights into the ecological and invasive attributes of *Leucaena leucocephala*, a tropical agroforestry species. Frontiers in Agronomy 4:890992. doi: 10.3389/fagro.2022.890992

Soejarto DD, Addo EM, Kinghorn AD. 2026. The continuing need for taxonomic input in phytochemical research. Journal of Ethnopharmacology 354:120474. doi: 10.1016/j.jep.2025.120474

Suciyati A, Suryadarma IGP, Paidi, Abrori FM. 2021. Ethnobotanical study based on the five dimensions of basic life needs in Tidung tribe of North Kalimantan, Indonesia. Biodiversitas 22:3199-3208. doi: 10.13057/biodiv/d220623

Sujarwo W, Keim AP, Savo V, Guarrera PM, Caneva G. 2015. Ethnobotanical study of Loloh: Traditional herbal drinks from Bali (Indonesia). Journal of Ethnopharmacology 169:34-48. doi: 10.1016/j.jep.2015.03.079

Sumadijaya A, Agustiani E, Senjaya S, Wulansari T. 2025. Reinwardtia, 75 years of endeavour investigating Indonesia's botany and beyond. Reinwardtia 24:137-144. doi: 10.55981/reinwardtia.2025.591

Sundhani E, Nugroho AE, Nurrochmad A, Puspitasari I, Amalia Prihati D, Lukitaningsih E. 2022. Pharmacokinetic herb-drug interactions of glipizide with *Andrographis paniculata* (Burm. f.) and andrographolide in normal and diabetic rats by validated HPLC method. Molecules 27:6901. doi: 10.3390/molecules27206901

Süntar I. 2020. Importance of ethnopharmacological studies in drug discovery: role of medicinal plants. Phytochemistry Reviews 19:1199-1209. doi: 10.1007/s11101-019-09629-9

Supiandi MI, Zubaidah S, Mahanal S. 2026. Medicinal leaf knowledge of the five Dayak ethnic groups in West Kalimantan, Indonesia. Biodiversitas 27(2):1-11. doi: 10.13057/biodiv/d270215

Surya R, Kumalawati DA, Tedjakusuma F, Subali D, Santini A, Nurkolis F. 2026. Profiling of consumer perception and acceptance of indigenous jamu beverages. Beverages 12:46. doi: 10.3390/beverages12040046

Sutomo, Aprilianes AV, Kartinah N, Arnida, Muslimawati K, Akbar NH. 2024. Ethnobotanical study of medicinal plants of Banjar and Java tribes in Pandansari Village, South Kalimantan. Borneo Journal of Pharmacy 7:136-146. doi: 10.33084/bjop.v7i2.6636

Sutomo, Awaliyah VV, Arnida. 2022. Ethnobotanical study and phytochemical screening of medicinal plants used by local people in Belangian Village, South Kalimantan. Borneo Journal of Pharmacy 5:1-8. doi: 10.33084/bjop.v5i1.2717

Tahsin MdR, Tithi TI, Mim SR, Haque E, Sultana A, Bahar NB, Ahmed R, Chowdhury JA, Chowdhury AA, Kabir S, Aktar F, Uddin MdS, Amran MdS. 2022. In vivo and in silico assessment of diabetes ameliorating potentiality and safety profile of *Gynura procumbens* leaves. Evidence-Based Complementary and Alternative Medicine 2022:1-18. doi: 10.1155/2022/9095504

Ting A, Chow Y, Tan W. 2013. Microbial and heavy metal contamination in commonly consumed traditional Chinese herbal medicines. Journal of Traditional Chinese Medicine 33:119-124. doi: 10.1016/S0254-6272(13)60112-0

Torimbanu AR, Saputra AF, Aulia AA, Utomo AN, Safira RN, Yasa A, Saensouk S, Setyawan AD. 2024. Ethnobotany of medicinal plants used by the Javanese community of Mount Merapi National Park, Central Java, Indonesia. Asian Journal of Ethnobiology 7:130-143. doi: 10.13057/asianjethnobiol/y070206

Ulfa R, Fatmah, Utomo SW. 2025. Short communication: Community knowledge and uses of sambiloto (*Andrographis paniculata*) in an urban herbal village, Surabaya, East Java, Indonesia. Biodiversitas 26:4017-4022. doi: 10.13057/biodiv/d260830

Ullah M, Mehmood S, Ali M, Bussmann RW, Aldosari A, Ali Khan R, Ullah R, Hussain W, Rahman Shah MA. 2019. An ethnopharmacological study of plants used for treatment of diabetes in the Southern and Tribal regions of Khyber Pakhtunkhwa province, Pakistan. Ethnobotany Research and Applications 18:1-20. doi: 10.32859/era.18.8.1-20

Umair M, Altaf M, Abbasi AM. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. PLoS ONE 12:e0177912. doi: 10.1371/journal.pone.0177912

UNEP-WCMC. 2026. Checklist of CITES species. CITES Secretariat, Geneva, Switzerland, and UNEP-WCMC, Cambridge, United Kingdom. https://checklist.cites.org (Accessed 14-20/10/2026).

Vandebroek I. 2010. The dual intracultural and intercultural relationship between medicinal plant knowledge and consensus. Economic Botany 64:303-317. doi: 10.1007/s12231-010-9135-y

Wahyono S, Jokopriyambodo W, Rahmawati N, Maruzy A, Widowati L, Subositi D, Haryanti S, Mustofa FI, Sari AN, Mujahid R, Widiyastuti Y, Budiarti M, Junediyono. 2017. Laporan nasional: eksplorasi pengetahuan lokal etnomedisin dan tumbuhan obat berbasis komunitas di Indonesia. Lembaga Penerbitan Badan Penelitian dan Pengembangan Kesehatan Kementerian Kesehatan RI, Jakarta, Indonesia. https://repository.badankebijakan.kemkes.go.id/id/eprint/3069/2/Eksplorasi%20Pengetahuan%20Lokal%20Etnomedisin%20dan%20Tumbuhan%20Obat%20Berbasis%20Komunitas%20di%20Indonesia.pdf (Accessed 21/01/2026).

Welch JR. 2022. Challenges and opportunities for ethical collaborative research: Social contours of A'uwẽ (Xavante) ethnobiological knowledge. Journal of Ethnobiology 42:51-68. doi: 10.2993/0278-0771-42.1.51

WHO. 2024. Diabetes. World Health Organization, Geneva, Switzerland. https://www.who.int/news-room/fact-sheets/detail/diabetes (Accessed 21/12/2025).

Zheng H, Mao X, Fu K, Qiao L, Deng P, Chen Y, Wu Y. 2026. Integrated niche and dispersal modeling reveals global expansion patterns and invasion risks of *Tithonia diversifolia* under CMIP6 climate scenarios. Ecological Indicators 182:114614. doi: 10.1016/j.ecolind.2026.114614

Zrineh A, Al-Usta M, Alwawi A. 2026. Sampling methods and sample size determination in clinical research: An educational review. Journal of General and Family Medicine 27:e70096. doi: 10.1002/jgf2.70096