ASIAN JOURNAL OF ETHNOBIOLOGY
Volume 9, Number 1, June 2026 E-ISSN: 2580-4510
Pages: 12 https://doi.org/10.13057/asianjethnobiol/y090120

Participatory research and development of indigenous herbal formulations for community health in Northeast Thailand and the Lao People's Democratic Republic (PDR)

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Manuscript received: 25 February 2026. Revision accepted: 11 April 2026.

Abstract. *Phon-ngam P. 2026. Participatory research and development of indigenous herbal formulations for community health in Northeast Thailand and the Lao People's Democratic Republic (PDR). Asian J Ethnobiol 9 (1): y090120. https://doi.org/10.13057/asianjethnobiol/y090120.* Traditional medicine remains a vital component of rural community health care in northeastern Thailand (Isan) and the Lao PDR. Rooted in indigenous knowledge shaped by local culture and ecological contexts, herbal medicine continues to function as a community-based health resource requiring systematic documentation and participatory development to ensure continuity and safe community use. This study aimed to (i) collect and analyze indigenous herbal medicine recipes used in community health care in Northeast Thailand and the Lao PDR; (ii) develop and refine herbal formulations through participatory processes involving traditional healers as co-researchers; and (iii) document community-based practices related to the application of harmonized herbal preparation guidance within routine health contexts. A participatory action research and Research and Development (R&D) design was employed, involving registered traditional healers, community leaders, and collaborating health professionals. Data were collected through interviews, participatory workshops, and field observations. Qualitative thematic analysis and methodological triangulation were applied to enhance analytical rigor and cultural validity. The study refined and documented 344 indigenous herbal formulations organized into 11 community-defined therapeutic categories reflecting locally recognized health concerns. A broader inventory of 566 medicinal plant species served as a reference resource informing formulation development. Participatory documentation and harmonized preparation guidance were collaboratively established to support clarity and consistency in community-level use.

Keywords: Indigenous herbal medicine, Isan, participatory action research, participatory documentation, Thai-Lao border

INTRODUCTION

Thailand and Laos, located within the highly biodiverse Mekong Sub-region, have long relied on medicinal plants as important components of community-based primary health care (Phumthum and Balslev 2019; WHO 2019). In rural and remote areas, particularly in Northeast Thailand (Isan) and along the Thai-Lao border, traditional medicine often serves as an accessible first-line healthcare option. This reliance reflects persistent geographical, economic, and infrastructural barriers that limit access to modern biomedical services (Tran et al. 2016). As a result, local communities continue to depend on indigenous healing practices that remain closely integrated into daily life and community health management (Phumthum and Balslev 2019; WHO 2019; Mahali et al. 2023)

Ethnobotanical and ethnomedical research confirms the continuing importance of plant-based remedies in rural societies. These practices represent indigenous knowledge shaped by local culture and environmental conditions (Kunwar and Bussmann 2008; Aziz et al. 2017; Bussmann and Sharon 2018; Jigme and Yangchen 2022; Candraningtyas et al. 2025; Irwansyah et al. 2025). In rural Laos and Northeast Thailand, traditional healers remain key providers of primary care, particularly for common and chronic conditions (Ong and Kim 2014; Phumthum et al. 2020). However, demographic change, migration, and expansion of health services have reduced opportunities for knowledge transmission, posing risks to healthcare access, cultural continuity, and biodiversity conservation.

Globally, interest in complementary and alternative medicine has increased due to growing recognition of the therapeutic potential of medicinal plants in managing major non-communicable diseases such as diabetes, cancer, and cardiovascular disorders (Salehi et al. 2019; WHO 2019). In Thailand and the Lao People's Democratic Republic herbal medicines continue to be widely used for both preventive and therapeutic purposes. However, systematic documentation and integration of traditional knowledge into community and formal health systems remain limited. Traditional healers also face challenges in transferring knowledge to younger generations and adapting to changing health service contexts. These conditions highlight the need for structured approaches that support knowledge preservation and community health resilience.

Ethnobiology provides a useful conceptual framework for understanding relationships among people, medicinal plants, and ecosystems within traditional health systems.

From this perspective, traditional healing practices can be understood as culturally embedded responses to environmental conditions and local health needs. In the Mekong borderlands, shared cultural histories and overlapping ecological zones have produced closely related yet locally distinct ethnomedical traditions. This regional interconnectedness supports the relevance of cross-border perspectives in studying indigenous health practices and community health systems.

Recent ethnobiological studies in Southeast Asia have documented extensive medicinal plant use and traditional therapeutic knowledge across diverse communities. For example, ethnobotanical research in Thailand has identified numerous plant species used for treating digestive and chronic conditions, demonstrating continued reliance on traditional medicine in rural populations (Ong and Kim 2014; Phumthum et al. 2020). Comparative studies among Thai ethnic groups further highlight the diversity of therapeutic practices and the cultural significance of herbal medicine in local healthcare systems (Phumthum et al. 2020). Similarly, regional research emphasizes the importance of systematic documentation for conservation and sustainable resource management (Bussmann et al. 2017). However, these studies primarily describe plant use and traditional practices rather than examining how herbal formulations can be collaboratively refined and applied through participatory processes in routine community healthcare. This gap highlights the need for research that links documentation with practical development of indigenous health knowledge.

Participatory research approaches provide a practical strategy for addressing this gap. By involving traditional healers and community members as active contributors to knowledge generation, participatory methods enable collaborative refinement of herbal formulations that reflect lived experience, culturally grounded therapeutic logic, and local health priorities. Such approaches support intergenerational knowledge transfer and strengthen community ownership of health practices. In cross-border settings such as the Thai-Lao Region, participatory collaboration can enhance understanding of shared patterns of herbal knowledge while recognizing context-specific variations in health practices and ecological resources.

Furthermore, participatory development of indigenous herbal formulations contributes directly to broader sustainability goals. Community-based health initiatives that promote responsible harvesting, local resource management, and preservation of medicinal plant biodiversity align with international development priorities, including improved primary healthcare access and sustainable use of natural resources. By integrating participatory research, indigenous knowledge, and sustainability-oriented analysis, the present study moves beyond descriptive documentation to demonstrate how collaborative refinement and practical application of traditional herbal formulations can strengthen community health systems in rural and resource-limited settings. This study aimed (i) to collect and analyze traditional herbal medicine recipes used in community healthcare in Northeast Thailand and Lao PDR, with an emphasis on preserving indigenous knowledge and local herbal resources; (ii) to develop and refine these formulations through participatory processes to support sustainable community health; (iii) to document practitioner-reported experiences regarding the use of standardized herbal formulations within local healthcare contexts.

MATERIALS AND METHODS

Target groups

The study was conducted in the Isan Region of Northeastern Thailand and in Vientiane Prefecture, Lao PDR, over a two-year period. The unit of analysis was indigenous herbal knowledge and its participatory harmonization process rather than clinical patient outcomes. Accordingly, the study focused on documentation and knowledge development within community health practices and did not aim to evaluate treatment efficacy or clinical effectiveness.

Participants were purposively selected based on predefined inclusion criteria, including demonstrated experience in traditional medicine practice, community recognition, and active engagement in knowledge transmission. Purposive sampling is widely used in qualitative research to identify information-rich participants with relevant expertise and contextual knowledge (Creswell and Poth 2018). Snowball sampling was subsequently used to identify additional knowledgeable practitioners recommended by initial participants, thereby ensuring representation of experienced community-based knowledge holders and strengthening the depth and reliability of community-based knowledge documentation (Miles et al. 2014).

The target groups included the participant categories:

Traditional healers (n=25): Licensed traditional healers officially certified by the Loei Provincial Public Health Office or recognized by local health authorities in Lao PDR. Inclusion criteria required a minimum of five years of active practice and routine use of indigenous herbal formulations in community settings. These practitioners served as primary knowledge custodians and led the clarification, comparison, and participatory harmonization of herbal formulations during structured workshops.

Community leaders (n=10): Village elders, cultural leaders, and community health volunteers involved in local health coordination and traditional knowledge preservation. Community leaders contributed contextual knowledge regarding local health priorities, cultural practices, and community acceptance of herbal treatments, supporting interpretation of community-level health practices.

Thai traditional medicine scholars (n=10): Academic or professional experts in Thai traditional medicine who provided technical consultation during the recipe clarification and harmonization process. Their roles included reviewing terminology, supporting classification of herbal ingredients, and advising on consistency of preparation logic across documented formulations.

Scholars contributed to analytical discussions but did not independently modify, or authorize treatment decisions.

Community patients (n=15): Individuals who voluntarily sought herbal treatment from licensed traditional healers as part of their routine health-seeking practices. Patients were not recruited for clinical evaluation or therapeutic testing. No biomedical measurements or diagnostic procedures were conducted by the research team. Treatment decisions were made independently by licensed healers within their professional scope of practice.

Information related to patient experiences was documented only as anonymized practitioner-reported narratives shared voluntarily during follow-up discussions. These narratives were used as qualitative data to inform thematic coding related to perceived treatment experiences, preparation feasibility, and community acceptance of herbal practices. The narratives were not used to infer clinical effectiveness, safety, or causal treatment outcomes.

All participants provided informed consent prior to participation. The study focused on documentation and participatory knowledge development and did not involve clinical intervention, biomedical testing, or experimental treatment procedures.

Research instruments

The study employed qualitative research instruments designed to systematically document indigenous herbal knowledge and its community-level application. These instruments supported consistent data collection across multiple participant groups and enabled systematic thematic analysis of herbal knowledge, preparation practices, and community health experiences.

Semi-structured interview guides

Interview protocols were developed to explore five core domains: (i) local illness classification systems, (ii) herbal ingredient identification and sourcing, (iii) preparation techniques and dosage practices, (iv) knowledge transmission pathways, (v) perceived treatment experiences in community settings. Interview guides were reviewed by two Thai traditional medicine scholars for content clarity and cultural appropriateness prior to field implementation.

Focus group discussion protocols

Focus group guides were designed to facilitate collective reflection on: (i) criteria for recipe standardization, (ii) variations in plant naming, (iii) harmonization decisions, (iv) community health priorities. This group were structured to guide key topics while allowing open dialogue to capture consensus-building processes and differing viewpoints among participants.

Participatory observation checklists

Structured observation templates were used during plant identification, harvesting practices, preparation procedures, and dosage demonstrations. These checklists ensured systematic recording of plant parts used, preparation steps, and contextual notes regarding sustainability practices and resource management.

Documentation tools

Data were collected using field notebooks, digital audio recorders (with informed consent), and photographic documentation for plant verification and process recording. All interviews and focus group discussions were audio-recorded and transcribed verbatim in the original language (Thai or Lao). Transcripts were subsequently translated into English by bilingual research assistants and cross-checked for linguistic accuracy by the research team.

A documentation log was maintained to record interview dates, participant categories, coding status, and stages of recipe refinement to support transparency, traceability, and auditability throughout the research process. Then, the details are summarized in Table 1.

To further strengthen analytical transparency, examples of the coding process were documented throughout data analysis. Participant narratives describing herbal preparation steps, dosage practices, and ingredient selection were systematically coded and grouped into thematic categories such as preparation procedures, ecological knowledge, and community health utilization. These coding practices enabled consistent comparison of herbal preparation patterns across participants and supported rigorous thematic interpretation of community-based herbal knowledge. The documented coding process also contributed to maintaining a clear audit trail of analytical decisions throughout the study.

Table 1. Key data collection domains and documentation procedures

Instrument type	Key domains / guiding questions	Recording method	Transcription and translation
Semi-structured interviews	Local illness classification; plant identification; preparation methods; dosage practices; knowledge transmission; practitioner-reported experiences	Audio-recorded with consent; field notes	Transcribed verbatim in Thai or Lao; translated into English by bilingual assistants; cross-checked by research team
Focus group discussions	Criteria for recipe standardization; ingredient harmonization; merging decisions; community health priorities	Audio-recorded; workshop minutes	Transcribed in original language; translated and verified collaboratively
Participatory observation	Plant harvesting practices; preparation steps; sustainability considerations	Observation checklist; field notes; photography	Descriptive notes prepared in Thai; translated into English during analysis
Documentation log	Recipe version tracking; consolidation decisions; participant category; coding status	Digital logbook	Maintained in English for audit trail purposes

Data collection procedures

Data collection and recipe development followed a Participatory Action Research (PAR) approach with traditional healers and community stakeholders in Northeast Thailand (Isan) and Lao PDR.

Stage 1: Community engagement and contextual exploration

Interviews, informal discussions, and participant observation were used to understand local health practices, the role of herbal medicine, and indigenous concepts of illness. Field notes documented socio-cultural contexts and healing practices.

Stage 2: Documentation and indigenous classification

Herbal recipes were documented through interviews and observation, including plant species, parts used, preparation, administration, and therapeutic purposes. Conditions treated were grouped according to indigenous disease classifications based on body systems.

Stage 3: Participatory harmonization and co-development

Documented herbal recipes were reviewed in structured participatory workshops involving licensed traditional healers and community representatives from Northeast Thailand and Lao PDR. The purpose of this stage was to clarify, compare, and harmonize documented formulations while preserving indigenous knowledge systems.

The criteria used to compare and harmonize herbal recipes were preliminarily identified prior to fieldwork and were further refined during participatory workshops with licensed traditional healers to ensure contextual relevance and practical applicability. Recipes were systematically compared based on ingredient composition, plant parts used, preparation logic, therapeutic indications, and local naming variations. Formulations demonstrating substantial structural similarity were discussed collectively to determine whether harmonization was appropriate. Minor differences in terminology, sequence of preparation steps, or non-essential ingredient substitutions were clarified through consensus dialogue. Consolidation decisions were made collaboratively by participating healers.

The co-development process was led by licensed traditional healers in accordance with their professional knowledge and community practice norms. The researcher acted solely as a facilitator and documentarian, ensuring systematic recording of discussions, clarification decisions, and agreed-upon preparation details. The researcher did not independently formulate, modify, or prescribe any herbal remedies.

All finalized formulations remained under the authority and custodianship of licensed traditional healers and were retained within the local healer association. A structured documentation log was maintained to record comparison criteria, workshop discussions, and rationale for harmonization decisions, forming part of the study's audit trail to enhance transparency and traceability.

Stage 4: Observation of community-based practice

The finalized herbal formulations were returned to the local traditional healer association, where licensed practitioners independently applied them as part of their routine professional practice within their lawful scope of care. The implementation of treatments was neither initiated nor directed by the research team.

The researcher did not prescribe, administer, modify, evaluate, or supervise any treatment procedures. Observation was strictly limited to documentation of preparation processes and general reflections voluntarily shared by patients and family members during routine follow-up interactions with healers.

Treatment notes were maintained by healer assistants as part of standard clinical practice. The researcher documented anonymized summaries of practitioner-recorded information for qualitative analysis purposes only and did not access or collect formal medical records. No biomedical measurements, diagnostic testing, or clinical outcome assessments were conducted by the research team.

Importantly, the study was not designed to test treatment effectiveness, safety, or therapeutic outcomes. Any observed changes in well-being were interpreted as experiential or contextual observations rather than clinical evidence of efficacy.

Stage 5: Reflection and feedback

After the developed herbal recipes had been used in traditional healer clinics, feedback was collected from community members and their families regarding perceived changes in well-being, ease of preparation, and cultural acceptability. These reflections were used solely to support refinement of documentation and understanding of community health practices. Such reflections represent subjective perceptions of users and were not analyzed as indicators of treatment effectiveness, clinical improvement, or health outcomes. The study did not involve controlled observation, outcome measurement, or experimental comparison. Data credibility was supported through triangulation of interviews, observations, and workshop records, as well as team-based review.

Summary of the five-stage process

The stages of exploration and engagement, documentation and indigenous classification, participatory development of herbal recipes, community-based application observation, and patient and family feedback were implemented in a cyclical manner. Continuous feedback supported refinement of community-based herbal recipes in response to local health needs in the Thai–Lao border region. Throughout all stages, the research focused on documentation, participatory knowledge development, and community practice processes rather than evaluation of clinical effectiveness or therapeutic efficacy.

Data trustworthiness

Data trustworthiness was enhanced through triangulation of interviews, observations, and participatory workshop records. Member checking was conducted with traditional healers and community leaders, and peer

debriefing with Thai traditional medicine scholars was used to support consistency and credibility.

Data analysis

Qualitative data were analyzed using thematic content analysis. An inductive coding approach was primarily employed to allow themes to emerge from participants' narratives, particularly in relation to herbal knowledge transmission, recipe harmonization, and practitioner-reported experiences. Limited deductive elements were incorporated to align analysis with the predefined research objectives and therapeutic classification framework.

Two researchers independently coded the interview and focus group transcripts. Initial coding was conducted separately to identify recurrent patterns and thematic categories. The coders then compared their coding outputs in structured consensus meetings. Coding discrepancies were discussed and resolved through agreement, and the outcomes of these consensus decisions were formally documented in coding records to ensure transparency and consistency. Code definitions were refined iteratively to enhance analytical reliability.

An analytic audit trail was maintained, documenting code development, theme refinement, and consolidation decisions. Records of coding concordance and resolution processes were retained as part of the formal documentation system, allowing traceability of analytical decisions throughout the study. Triangulation was applied analytically by cross-comparing data from semi-structured interviews, focus group discussions, participatory observations, and documentation logs. Themes were confirmed only when supported by multiple data sources through triangulation, thereby strengthening credibility and reducing single-source bias.

Descriptive statistics were used to summarize the number of herbal species, therapeutic categories, and stages in the standardization workflow. These statistics served a descriptive documentation purpose rather than inferential analysis.

Ethical considerations

This study did not involve clinical experimentation or intervention with human participants. The researcher did not diagnose, treat, or prescribe herbal remedies to patients. All health care activities were carried out independently by licensed traditional healers who are legally authorized to provide treatment under Thai traditional medicine regulations.

The role of the researcher was limited to documenting indigenous herbal knowledge and compiling practitioner-reported experiences related to the use of harmonized herbal formulations in routine community practice. Prior to data collection, written informed consent was obtained from participating healers and community members who voluntarily agreed to share their knowledge and experiences. Participants were informed that they could decline or withdraw from participation at any time without any negative consequences. All information was treated confidentially and used solely for academic purposes.

At the time the research activities were conducted, a formal Institutional Review Board had not yet been established within the author's institution. Ethical oversight was provided through collaboration with the local traditional healer association and community governance mechanisms, ensuring that documentation activities respected cultural norms, participant autonomy, and confidentiality.

AI use statement

The manuscript was originally developed in Thai based on field-based research and participatory documentation of indigenous herbal knowledge. Artificial Intelligence (AI) tools were used only to support language translation and grammatical editing in English. All research design, data collection, analysis, and interpretation were conducted by the authors.

RESULTS AND DISCUSSION

This study applied a Participatory Action Research (PAR) process to document, refine, and apply indigenous herbal formulations used for community health care in the Isan Region of Thailand and Lao PDR. The results highlight not only the diversity of ethnomedical knowledge in the region but also its practical role in supporting everyday health practices within rural communities.

A key feature of the research design is the distinction between two related yet analytically separate datasets. The first consists of an inherited botanical inventory derived from earlier ethnobotanical documentation conducted in the same geographic area. The second comprises a newly examined set of community-level herbal formulations that were refined and standardized through participatory collaboration. Making this distinction helps clarify how long-standing knowledge systems continue to evolve while also demonstrating the specific analytical contribution of the present study.

Collection of indigenous herbal recipes and disease classification

Through a participatory action research approach, indigenous herbal medicine practices used for routine community health care in Northeast Thailand (Isan) and Lao PDR were systematically documented. During the exploratory phase, researchers recorded 566 medicinal plant species together with 351 existing herbal formulations obtained from licensed traditional healers and knowledgeable community members. These materials were subsequently reviewed during participatory workshops and cross-border knowledge exchange activities. Similar formulations were grouped together, ingredient compositions were clarified, and preparation procedures were adjusted to improve consistency and shared understanding among participants. In several instances, new formulations were jointly developed on the basis of shared local knowledge. The final number of harmonized herbal preparations, therefore reflects an ongoing process of documentation, discussion, and collective refinement.

The list of 566 medicinal plant species referenced in this study originates from the author's earlier ethnobotanical investigation conducted in the same region (Phon-ngam 2019). Building on that established foundation, the present research concentrates on the collaborative refinement and harmonization of herbal formulations used at the community level. In practical terms, the botanical inventory represents previously recorded ethnobotanical resources, whereas the formulation dataset analyzed in this study reflects newly standardized herbal preparations shaped through participatory interaction among practitioners.

Based on the experiential knowledge of traditional healers, 35 commonly treated health conditions were identified and organized into 11 therapeutic categories that follow indigenous diagnostic reasoning. These categories include digestive, respiratory, musculoskeletal, circulatory, nervous system, skin, poisoning, vitality and rejuvenation, urinary and reproductive, endocrine (diabetes), and other conditions such as fever and cancer (Table 2).

Rather than strictly following biomedical disease classifications, these groupings represent functional and symptom-oriented categories grounded in local health concepts. Some categories broadly correspond to biomedical body systems, such as digestive or respiratory conditions, whereas others particularly vitality and rejuvenation reflect culturally embedded interpretations of balance, strength, and well-being.

Digestive, respiratory, and musculoskeletal disorders appeared most frequently in the dataset. This pattern is consistent with the daily realities of rural agrarian communities, where physical labor, environmental exposure, and seasonal living conditions strongly influence patterns of illness and recovery. The distribution of health conditions across the 11 categories is summarized in Table 2.

Table 2 indicates that 35 health conditions treated with indigenous herbal medicine were organized into 11 body systems. Digestive, respiratory, and musculoskeletal conditions accounted for the largest proportions, suggesting that these concerns represent dominant health priorities within rural communities. The classification also demonstrates that traditional medical knowledge is structured in a coherent and systematic manner that responds to routine health needs.

Analysis of traditional herbal medicine recipes used for community health care

Examination of the collected formulations revealed that traditional healers tend to organize treatment according to functional body systems and observable symptom patterns rather than formal biomedical diagnoses. In practice, herbal remedies are selected by considering perceived causes of illness, the physical condition of the patient, surrounding environmental conditions, and accumulated professional experience.

The distribution of formulations across the 11 disease categories showed that musculoskeletal (56), respiratory (55), and digestive (51) conditions accounted for the largest numbers of treatments. These trends align with labor-intensive livelihoods, frequent exposure to environmental factors, and dietary practices commonly observed in rural agricultural settings along the Thai-Lao border. By contrast, circulatory (17) and endocrine (11) conditions were less frequently represented, indicating a more limited presence of these conditions within traditional therapeutic routines.

From an ethnobiological perspective, the prominence of musculoskeletal, respiratory, and digestive conditions reflects the close relationship between health, environment, and subsistence activities in rural communities. Repetitive physical work, seasonal climate variation, exposure to dust or smoke, and reliance on locally available foods contribute to recurring patterns of physical strain, respiratory discomfort, and gastrointestinal disturbances. Within this setting, indigenous herbal medicine serves as a practical and adaptive health resource grounded in ecological knowledge, cultural belief systems, and locally accessible plant materials. Overall, the evidence suggests that indigenous herbal medicine in the Thai-Lao Isan Region functions as an organized, experience-based system of care that supports a wide range of community health practices while sustaining traditional knowledge and strengthening local health resilience.

Development and refinement of herbal formulations through participatory processes to support sustainable community health

Following the initial collection and classification of indigenous herbal recipes, the second phase of the study concentrated on refining and harmonizing selected formulations through collaborative engagement with traditional healers. The purpose of this stage was to improve the clarity, consistency, and practical usability of documented herbal knowledge in community health settings. Activities were organized through structured group discussions and consensus-oriented workshops involving licensed healers from the Isan Region of Thailand and neighboring communities in Lao PDR.

These participatory meetings were not designed as clinical trials. Instead, they provided a space for practitioners to review existing knowledge collectively and ensure that recorded information accurately reflected real-life practice. During the sessions, healers revisited the 351 originally documented community herbal recipes and shared their experiences regarding preparation methods, regional variations, and common patterns of use in routine care.

Through ongoing dialogue and shared reflection, similar or overlapping formulations were carefully examined and, where appropriate, combined. Minor differences were clarified, ingredient descriptions were standardized, and preparation procedures were described more consistently. In several cases, incomplete or fragmented records were reorganized into clearer formats. A small number of formulations were also jointly developed when practitioners recognized shared knowledge across communities along the Thai-Lao border.

Table 2. Classification of diseases by body systems treated with indigenous herbal medicine

Body system	Diseases/Health conditions
Digestive system	Diarrhea, dysentery, abdominal pain, gastritis, intestinal inflammation, stomach ulcers, intestinal ulcers
Respiratory system	Tuberculosis, lung disorders, asthma, bronchitis, cough, allergic rhinitis
Musculoskeletal system (muscles and tendons)	Muscle pain, tendon disorders, gout, paralysis, limb numbness, joint pain
Circulatory system	Hypertension, hypotension, blood circulation disorders
Nervous system	Stress-related disorders
Skin system	Ringworm, scabies, fungal infections, itching, chronic wounds, herpes zoster
Poisoning and toxic substances	Animal bites, all types of poisoning
Vitality and rejuvenation	Body nourishment, vitality enhancement
Urinary and reproductive systems	Urinary tract disorders, kidney stones, uterine inflammation, ovarian inflammation, leukorrhea, abnormal vaginal discharge, irregular menstruation
Endocrine system (diabetes)	Obesity-related diabetes, chronic diabetes, non-insulin-dependent diabetes
Other conditions (e.g., fever and cancer)	Fever and various types of cancer

During the refinement process, preparation steps were simplified to make the instructions easier to follow in everyday situations. Herbal ingredients were identified more precisely, and approximate proportions were recorded when this information was traditionally available. Methods of preparation and customary modes of use were described in a more structured manner so that community members could apply the formulations with greater confidence. These adjustments were intended to ensure that the documented remedies remained accessible for household and community health practices without requiring specialized equipment or formal medical facilities.

Example of consolidation logic in participatory harmonization

To illustrate how consolidation decisions were made in practice, one representative case is presented. Two herbal remedies traditionally used for muscle pain and joint stiffness were recorded from different villages. Although the recipes used slightly different local plant names and preparation sequences, both contained the same principal ingredients, including locally available plants known for their anti-inflammatory and warming properties. During workshop discussions, healers recognized that the therapeutic intention and functional composition of the two remedies were essentially the same.

After careful discussion, participants agreed to combine the two recipes into a single harmonized preparation. The revised formulation retained the shared core ingredients while presenting preparation steps and dosage guidance in a clearer format. Minor differences in terminology or sequence were documented as acceptable local variations rather than treated as separate formulations. This example demonstrates that consolidation decisions were guided by therapeutic similarity, ingredient compatibility, and collective professional judgment rather than by the goal of reducing numbers alone.

The 351 documented formulations represented historically used community remedies gathered during earlier fieldwork. During the participatory refinement process, seven formulations were merged into existing recipes because they served similar therapeutic purposes and because certain plant ingredients had become less readily available in local ecosystems. Their therapeutic principles were preserved within revised formulations rather than removed from the record. Through collaborative discussion and adaptive decision-making, community participants ultimately finalized 344 herbal formulations considered appropriate for current local use.

As a result of this process, 344 indigenous herbal formulations were prepared for structured documentation. Compared with the original records, the finalized versions were more clearly organized, described in consistent language, and recorded in a systematic format while maintaining the essential principles of traditional healing practice. The documentation, therefore supports knowledge preservation and intergenerational learning within community health settings and should not be interpreted as clinical validation or formal medical standardization.

Distribution of finalized herbal formulations by health condition

The finalized set of 344 indigenous herbal formulations was categorized according to the symptoms and health conditions they addressed. Each formulation was assigned to a relevant health category based on practitioner knowledge and observed patterns of use (Table 3).

Community perspectives on knowledge harmonization

Participant quotations were included to illustrate practitioner perspectives on the documentation and harmonization process. These statements were selected to represent commonly shared views about knowledge preservation and the transfer of experience between generations rather than to describe individual treatment outcomes.

As one senior traditional healer explained:

"Before, the recipes were remembered differently by each healer. Now we agree on how to prepare and use them, so the knowledge will not disappear." (Traditional healer, age 58, Loei Province)

Another participant highlighted the educational value of written documentation:

"Now that the recipes are written in a clear form, the younger generation can learn them more easily. They see that our local plants are valuable." (Traditional healer, age 55, Loei Province)

Overall, this phase shows how collaboration among traditional healers can strengthen the documentation of orally transmitted and experience-based knowledge. The process improved consistency in recorded information, supported long-term preservation of local knowledge, and increased the practical usability of herbal formulations in routine community health care. At the same time, the work remained focused on documentation and community practice rather than clinical testing or biomedical standardization.

Documentation of practitioner-reported experiences in local health contexts

Practitioner-reported experiences in routine community practice

Following the participatory development of 344 standardized indigenous herbal formulations organized into 11 therapeutic categories (Table 2), selected formulations were subsequently applied within routine community-based traditional health care settings. The choice of formulations for everyday use was guided by their frequency of application, relevance to commonly encountered local health concerns, and shared agreement among licensed traditional healers.

These applications took place as part of normal service delivery within licensed traditional healer clinics. No experimental intervention or researcher-directed treatment was introduced during this phase. The researcher maintained an observational role, documenting practitioner perspectives and voluntary feedback from patients or caregivers as these experiences naturally emerged during routine care.

In daily practice, the formulations were used to support a range of frequently encountered health concerns, including diabetes-related symptoms, musculoskeletal and stroke-related conditions, digestive discomfort, cancer-related discomfort, and general vitality support. Documentation focused on practical aspects of everyday functioning, such as the ability to continue routine activities, perceived comfort during normal tasks, and maintenance of usual daily routines as described voluntarily by patients or family members during follow-up interactions. These observations were recorded descriptively and did not involve clinical measurements, diagnostic testing, or standardized outcome assessments.

Practitioners also documented any unexpected experiences that arose during routine consultations. Such observations were recorded in narrative form based on information voluntarily communicated by patients or caregivers during subsequent visits or informal communication. Monitoring occurred within the context of ordinary care rather than through formal safety surveillance systems. No structured pharmacovigilance procedures, clinical monitoring programs, or experimental safety protocols were implemented. Selected illustrative examples of practitioner-reported community experiences observed during routine use of specific herbal formulations are summarized in Table 4.

The documented records, therefore reflect practitioner perspectives gathered during routine care within licensed traditional healer practices. They describe continuity of daily functioning, perceived comfort during everyday activities, and sustained participation in routine community life as communicated voluntarily by patients or caregivers. These observations should be understood as descriptive accounts of community practice rather than as evidence of clinical effectiveness or therapeutic outcomes. No serious adverse experiences were reported within the documented routine practice contexts.

Table 3. Classification of indigenous herbal recipes by body system or ailment reported in community practice

Body system/Ailment	Number of recipes
Digestive	51
Respiratory	55
Musculoskeletal	56
Circulatory	17
Nervous	14
Skin	35
Poisoning	14
Vitality/Rejuvenation	12
Urinary/Reproductive	26
Endocrine (Diabetes)	11
Other (Fever, Cancer)	53
Total	344

Table 4. Illustrative practitioner-reported community experiences in routine use of selected indigenous herbal formulations

Therapeutic category	Example health concern (community context)	Practitioner-reported community experiences	Adverse experiences (narrative reports)
Diabetes-related support	Diabetes-related symptoms	Continued routine daily functioning and perceived comfort during daily activities as voluntarily reported by patients or caregivers	No serious adverse experiences reported
Musculoskeletal and stroke-related support	Stroke-related movement limitations	Continued participation in routine daily activities and movement patterns as reported during follow-up interactions	Mild fatigue occasionally reported
Digestive system support	Digestive discomfort	Practitioner-reported improvement in comfort during routine eating and digestion-related activities	No serious adverse experiences reported
Cancer-related support	Cancer-related discomfort	Continued routine functioning and perceived comfort during daily activities as voluntarily communicated by patients or caregivers	Occasional nausea reported
General vitality support	General weakness or fatigue	Continued engagement in routine daily activities and perceived improvement in general well-being during routine functioning	No serious adverse experiences reported

Community-level evaluation and sustainability implications

Information about application experiences was derived primarily from voluntary feedback shared by patients and family caregivers following routine treatment encounters. Emphasis was placed on practitioner observations of daily functioning, participation in routine activities, and perceived comfort rather than on laboratory-based or experimental evaluation

Accounts from practitioners and caregivers described continued mobility among individuals with musculoskeletal or stroke-related conditions, maintenance of everyday functioning among those managing diabetes-related symptoms, and perceived comfort among individuals experiencing digestive or cancer-related discomfort. These descriptions reflect routine experiences observed in community health settings and suggest that structured documentation can enhance clarity and consistency in traditional practice without altering its cultural foundations.

At the community level, the participatory development and ongoing use of indigenous herbal formulations also supported continuity of traditional health knowledge and awareness of local resources. Clearer documentation improved communication among practitioners and created opportunities for knowledge sharing between experienced healers and younger community members.

The availability of written formulations further assisted local health workers and community members in maintaining continuity of culturally familiar health practices within their daily routines. Discussions during participatory workshops indicated that clearer documentation increased confidence in preparing and applying traditional remedies while preserving established cultural practices.

Licensed traditional healers within regional healer networks subsequently incorporated the developed formulations into their routine professional activities. Reported experiences emphasized maintenance of daily functioning and continuity of care within community settings rather than experimentally verified treatment outcomes. Continued use of documented formulations also supported coordination among practitioners and encouraged shared understanding of preparation procedures across the healer network. Taken together, these observations represent routine practitioner experiences within community care environments and should be interpreted as descriptive documentation of community practice rather than as clinical evaluation or experimental evidence.

Sustainability and SDG alignment

The participatory development and routine use of indigenous herbal formulations were associated with observable community practices related to health support, responsible resource use, and knowledge transmission. These practices correspond to selected Sustainable Development Goals (SDGs) based on directly observed community activities rather than measured population-level indicators.

Routine use of culturally familiar herbal formulations in community clinics illustrates the contribution of traditional health services to accessible primary health care at the local level, consistent with SDG 3 (Good Health and Well-being). Community members continued to rely on locally available herbal resources as part of everyday care practices, particularly in areas where access to formal medical services remains limited.

Guidance on plant selection, harvesting, and preparation methods documented during participatory workshops reflects responsible management of local natural resources consistent with SDG 12 (Responsible Consumption and Production). During these sessions, traditional healers discussed seasonal availability of plant materials, sustainable harvesting approaches, and appropriate storage practices to maintain the quality of herbal ingredients.

The systematic documentation and teaching of medicinal plant knowledge within healer associations also reflects ongoing community awareness of plant conservation and biodiversity stewardship consistent with SDG 15 (Life on Land). Training activities and intergenerational knowledge-sharing events within healer networks contributed to continued engagement in preserving traditional ecological knowledge. Overall, the community practices described in this section demonstrate how structured documentation and routine use of indigenous herbal formulations can help sustain culturally grounded health practices while encouraging responsible resource use and long-term knowledge preservation within community health systems

Table 5 illustrates that participatory documentation and routine use of indigenous herbal formulations were associated with observable community practices related to health support, responsible resource management, and knowledge continuity. The alignment with selected SDGs is therefore based on documented community activities within the study context rather than on quantitative sustainability indicators.

Table 5. Alignment of indigenous herbal practices with selected Sustainable Development Goals (SDGs) based on observed community activities

Sustainable development goal	Directly observed community practice	Evidence source within study
SDG 3-Good Health and Well-being	Routine use of standardized herbal formulations within community-based traditional health care services	Practitioner-reported routine care documentation
SDG 12-Responsible Consumption and Production	Clarification of plant harvesting and preparation practices discussed during participatory workshops	Workshop documentation and practitioner records
SDG 15-Life on Land	Community-level documentation and transmission of medicinal plant knowledge through healer associations	Training discussions and documentation logs

Discussion

Documentation and analysis of traditional herbal medicine for community health care

Systematic documentation within a biocultural health system. This study focused on the participatory documentation and refinement of 344 herbal formulations across Northeast Thailand and Lao PDR, drawing upon an existing inventory of 566 medicinal plant species. The emphasis on formulations rather than plant inventory highlights that indigenous herbal medicine functions as a structured biocultural health system embedded within local ecological, cultural, and social contexts rather than as isolated remedies. Such system-based characteristics are consistent with global evidence showing that traditional medicine in rural settings operates as an integrated component of primary health care systems (WHO 2019, 2025a, b).

The predominance of musculoskeletal, respiratory, and digestive formulations reflects health patterns associated with agrarian livelihoods, environmental exposure, and limited access to biomedical services. Similar patterns have been documented in ethnobotanical studies in Thailand and other rural regions, where physically demanding labor and environmental conditions strongly influence therapeutic priorities (Phumthum and Balslev 2019)These findings support ethnobiological perspectives that conceptualize traditional medicine as a dynamic and adaptive knowledge system shaped through long-term interactions between people, environment, and health needs rather than fixed pharmacological categories (Ong and Kim 2014; Albuquerque et al. 2019).

The relatively lower representation of endocrine and circulatory formulations suggests the gradual incorporation of non-communicable diseases into indigenous therapeutic frameworks. This reflects global epidemiological transitions in which chronic diseases are increasingly managed within pluralistic health systems that combine biomedical and traditional approaches (WHO 2025a, b)

Cross-border similarities in plant use and therapeutic reasoning across the Thai–Lao borderlands further indicate shared ethnomedical heritage within the Mekong region. Such continuity aligns with studies emphasizing that ecological connectivity and cultural exchange contribute to the transmission and persistence of medicinal plant knowledge across cultural boundaries (Cámara-Leret and Bascompte 2021; Fernández-Llamazares et al. 2021).

Importantly, participatory documentation demonstrates that indigenous medicinal knowledge is dynamic rather than static. Communities continuously adjust formulations according to ecological availability, therapeutic experience, and changing health needs. This adaptive process is widely recognized in participatory ethnobotany as a key mechanism for maintaining resilience in traditional knowledge systems under conditions of environmental and social change (Bussmann and Sharon 2016) Therefore, the findings illustrate that indigenous medical knowledge functions as a living, adaptive biocultural health system embedded within rural and cross-border Southeast Asian contexts.

Analytical structure of disease classification within indigenous health systems. The classification of 35 health conditions into 11 therapeutic categories suggests that indigenous herbal medicine in the Isan-Lao borderlands functions as an organized knowledge system rather than a set of discrete remedies. Rather than emerging from fixed biomedical categories, the grouping reflects how local healers interpret illness through symptoms, bodily function, and lived experience. Such interpretive logic corresponds with ethnomedical understandings of health as culturally constructed and context-dependent (Bussmann and Sharon 2018).

What becomes evident in the distribution of categories is the close alignment between health patterns and everyday conditions of agrarian life. Musculoskeletal, respiratory, and digestive conditions dominate, reflecting patterns of physical labor, environmental exposure, and limited biomedical accessibility. Similar observations have been reported in other ethnobotanical settings where therapeutic priorities mirror ecological and occupational realities rather than formal disease taxonomies (Ong and Kim 2014; Albuquerque et al. 2019).

Lower representation of endocrine and circulatory conditions may indicate a gradual incorporation of chronic diseases into indigenous reasoning systems rather than their historical absence. This shift reflects broader transitions in Southeast Asia, where non-communicable diseases are increasingly interpreted through existing symptom-based frameworks (WHO 2025a, b).

Taken together, the classification system shows how therapeutic knowledge is structured around practical health demands. Indigenous healers, therefore operate within a functional healthcare logic that remains embedded in community life while still maintaining internal coherence as a system.

Development of indigenous herbal recipes through participatory processes to support sustainable community health

The refinement of 344 herbal recipes through participatory engagement represents a shift from passive documentation to active knowledge negotiation. Instead of simply recording inherited formulations, the process involved reinterpretation, correction, and contextual adaptation by practitioners who hold experiential authority over medicinal practice.

The reduction from 351 recorded formulations to 344 refined recipes reflects consolidation rather than loss. Decisions were made collectively as healers compared variants, clarified ingredient ratios, and reassessed relevance based on current ecological availability. This process can be understood as a form of epistemic co-production in which knowledge is continuously validated through practice (Bussmann and Sharon 2018).

Adaptation played a central role in this refinement. When certain plant species were no longer accessible, substitutes with comparable therapeutic properties were selected based on collective experience. Such substitutions illustrate ecological responsiveness and biocultural adaptation rather than simplification of knowledge.

Disagreements regarding preparation strength or composition were resolved through discussion grounded in therapeutic outcomes and patient tolerance.

In this context, clarification does not mean standardization in a biomedical sense. It refers instead to making preparation methods and dosage instructions more usable within everyday practice. Healers noted that structured documentation helped reduce ambiguity and supp

Through this process, traditional healers strengthened their position within community health systems not only as knowledge holders but also as active participants in the regulation and continuity of therapeutic practice. The collective validation process reinforced shared responsibility, consistency of practice, and intergenerational knowledge transmission within community health networks.

Sustainability in this system, therefore emerges through continual renewal of knowledge rather than preservation alone, with adaptation embedded in everyday practice rather than imposed externally.

Strengthening community health practice through participatory use of indigenous herbal medicine

Indigenous herbal medicine remains deeply integrated into everyday community health practices through cooperation between healers, households, and local health services. The participatory development of recipes did more than organize knowledge; it shaped how care is delivered in practice.

Healers reported that clearer documentation improved consistency in preparation and increased confidence in treatment decisions, particularly when knowledge was transferred across generations. This contributed to more stable patterns of care for common conditions such as musculoskeletal pain, digestive problems, and minor infections.

From the perspective of community members, herbal treatments were valued for accessibility and cultural familiarity. Rather than replacing biomedical services, they were often used as an initial response to symptoms or for ongoing management of well-being. When conditions exceeded local capacity, referral to formal healthcare remained part of the treatment pathway, indicating functional complementarity between systems.

Interaction among practitioners also became more structured. Regular exchanges of experience allowed healers to compare outcomes, adjust formulations, and reinforce shared standards of practice. This form of continuous dialogue supported collective governance of therapeutic knowledge rather than isolated decision-making.

Overall, the findings suggest that participatory documentation strengthens both continuity and adaptability of community health practice. It supports knowledge transmission, improves clarity in application, and reinforces trust between practitioners and community members. These factors collectively contribute to the resilience of locally governed health systems.

Continuity of care within community health systems. Indigenous herbal medicine remains embedded in everyday primary care practices within rural communities of Northeast Thailand and Lao PDR. Its use is particularly evident among older adults, who continue to rely on familiar therapeutic practices shaped by long-term cultural experience. The consistency of preparation procedures reported by healers appears to contribute to patient confidence, as treatments are delivered in a predictable and comprehensible manner, reinforcing trust in local health providers (WHO 2019).

In practice, herbal medicine often functions as an initial response to common, non-severe conditions such as musculoskeletal pain, fatigue, or digestive discomfort. When symptoms persist or worsen, patients are referred to biomedical facilities. This pattern reflects an integrated care logic rather than parallel systems, where traditional healers operate within the limits of their practice while maintaining responsibility for patient safety. Such referral behavior aligns with evidence from pluralistic health systems in which traditional and biomedical services coexist in complementary roles (WHO 2025a, b).

The availability of documented recipes contributes to continuity of care across generations of practitioners. Younger healers reported that structured documentation reduces reliance on memory and facilitates more efficient learning of preparation techniques. This becomes particularly relevant in contexts where experienced healers are aging and knowledge transmission is increasingly vulnerable to interruption (Cámara-Leret and Bascompte 2021).

Community trust and cultural acceptability of herbal care. Trust emerges as a central factor sustaining the continued use of indigenous herbal medicine. Patients tend to favor treatments prepared by local healers due to familiarity with ingredients and transparency in preparation. In many cases, these remedies are embedded in family knowledge systems that have been transmitted across generations, reinforcing their legitimacy within community health behavior (Ong and Kim 2014; Reyes-García et al. 2019; Fernández-Llamazares et al. 2021).

Cultural acceptability further shapes health-seeking decisions. Herbal medicine is not perceived as an external or specialized intervention but as part of everyday domestic practice. Households frequently manage minor ailments using simple preparations, while more complex formulations are prepared by experienced healers. This shared therapeutic knowledge strengthens continuity between domestic care and community-based healing systems (Ong and Kim 2014; Cámara-Leret and Bascompte 2021).

Participatory documentation reinforces this trust by making knowledge more transparent. When healers explain ingredient functions and preparation methods, patients gain clearer understanding of treatment processes, which supports informed and responsible use. Such transparency reflects broader principles of people-centered care, where communication and shared understanding are essential to effective health systems (WHO 2025a, b).

From a policy perspective, these findings suggest that indigenous herbal medicine can play a complementary role within rural primary health care systems where it is already widely practiced. Supportive frameworks that ensure safe preparation, sustainable plant use, and protection of local knowledge may enhance both safety and effectiveness (WHO 2025a, b). Collaboration between licensed traditional practitioners and primary health care providers could further strengthen integration, particularly through capacity-building in plant identification, hygiene practices, and standardized preparation techniques.

At the community level, strengthening communication and referral pathways may improve patient safety while maintaining cultural relevance of care. Future research may benefit from observational and mixed-method approaches to examine preparation consistency, safety profiles, and real-world usage contexts of herbal formulations. Broader interdisciplinary studies linking ethnomedicine with biodiversity conservation and socio-economic sustainability may further clarify the long-term role of indigenous health systems in changing ecological and health landscapes.

In conclusion, this study demonstrates that participatory documentation and collaborative refinement strengthen the organization and continuity of indigenous herbal medicine within community health systems. Rather than merely preserving traditional knowledge, the process contributes to structuring dispersed practices into more accessible and transferable forms. This enhances intergenerational learning and supports the sustained use of ethnomedical knowledge in everyday care.

ACKNOWLEDGEMENTS

The author sincerely thanks the traditional healers, community members, and local stakeholders in Thailand and Lao PDR for their valuable participation and knowledge sharing. Appreciation is also extended to colleagues and institutions who provided support and constructive suggestions during the research process. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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