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# AI-Assisted Ethnobotanical Synthesis of Medicinal Plants Used for Toothache and Oral Pain in Southern Iran: A Systematic Review and Qualitative Analysis

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**A B S T R A C T**

**Objective:** This study aimed to systematically synthesize ethnobotanical evidence on medicinal plants used for toothache and to examine cross-study replication, geographic variation, preparation practices, and variation in reported indications.

**Methods:** Published ethnobotanical and ethnopharmacological studies from Fars, Hormozgan, Bushehr, and Khuzestan were systematically reviewed up to 25 September 2026. Eligible records were classified into direct toothache/dental-pain evidence, oral-analgesic evidence reported within an explicitly oral-disease context, and broader dental/oral-care evidence. Plant names were taxonomically harmonized using authoritative botanical databases. AI-assisted procedures were used to support literature matching, spelling and synonym screening, structured evidence organization, and identification of candidate taxon–indication–geography patterns. No AI-generated output was accepted as evidence without manual verification against the original source and, where relevant, authoritative botanical resources. Qualitative synthesis followed a thematic approach.

**Results:** Fourteen independent primary studies were included. The strict evidence set comprised 56 source rows representing 50 harmonized taxa from 24 families; 43 rows explicitly concerned toothache, tooth pain, or dental pain, whereas 13 represented oral-analgesic use within an explicitly oral-disease study and were therefore not treated as direct toothache records. Asteraceae and Lamiaceae were the most represented families. Cross-study replication was limited: 47 of the 50 taxa were reported in only one independent study. *Solanum nigrum, Zataria multiflora, and Matricaria chamomilla* were the only taxa replicated across multiple Southern-Iran studies. The broader oral-care layer included evidence related to gingival care, dental or oral infection, oral hygiene, and other oral-care practices, with geographic variation in reported indications.

**Conclusion:** Southern-Iran ethnobotanical evidence shows high local diversity with a small recurrent core. Source-level verification and taxonomic harmonization supported a more traceable synthesis, while AI-assisted procedures were used to support evidence organization and candidate pattern identification under manual verification. Recurrent taxa may provide an ethnobotanical basis for selecting candidates for further investigation, but recurrence alone should not be interpreted as evidence of clinical efficacy or safety.

**Keywords:** Ethnobotany; Medicinal plants; Toothache; Artificial intelligence; Southern Iran

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## Introduction

Toothache is a symptom rather than a single disease entity. It may arise from dental caries, pulpal or periapical inflammation, periodontal disease, trauma, or other odontogenic conditions, and inflammatory processes are frequently involved in the generation of dental pain. Analgesic medicines can reduce symptoms while definitive dental treatment is being arranged, but pain relief does not remove the underlying cause. Alongside conventional care, plant-based remedies have long been used in many communities to manage dental pain, particularly where medicinal plants are familiar, locally available, and embedded in household or traditional systems of care [1,2].

The range of plants associated with toothache is unusually broad. A global ethnomedicinal review identified records from Africa, Asia, Europe, the Americas, and Oceania and showed that remedies for dental pain span numerous botanical families and phytochemical groups [1]. This diversity should not be interpreted as evidence that these plants are clinically interchangeable. Rather, it points to a substantial body of locally maintained therapeutic knowledge, much of which has remained at the stage of ethnobotanical documentation or preclinical investigation [1,2].

Iran provides a particularly informative setting for examining this knowledge. Medicinal-plant use in the country reflects both a long medical tradition and highly localized ethnobotanical practices, and national reviews have documented hundreds of taxa associated with traditional health uses [3]. Field surveys reveal a more geographically specific picture. Ahmadipour et al. recorded 20 plants used specifically for toothache in Shiraz [4], while the Hormozgan survey documented 150 medicinal and functional species from 53 families and showed that painful disorders formed an important part of local medicinal-plant use [5]. Studies from Arjan–Parishan, southern Fars, Behbahan, northeastern Khuzestan, Minab–Rudan, and other southern localities likewise demonstrate that the composition of the medicinal flora, preferred plant parts, preparation practices, and therapeutic indications can vary substantially between communities [6–11].

This geographic variability is not merely a problem of species distribution. In ethnobotanical evidence, a medicinal record is better understood as a relationship between a tax on, an indication, a locality, and a practice of preparation or administration. The same plant may therefore occupy different therapeutic roles in different communities. Conversely, different taxa may be used locally for the same complaint. Treating a plant name alone as the unit of interpretation can obscure these relationships and can create an impression of consistency that is not supported by the underlying field reports [5–11,14].

The literature on Iranian remedies for toothache is now sizeable, but it remains unevenly organised. Recent reviews have assembled plants described as anti-toothache remedies or dental anaesthetics across Iran [12,13], while another review approached the subject through Iranian traditional-medicine sources and identified 58 medicinal plants associated with toothache [2]. These studies are valuable for mapping the field. Their purpose, however, differs from a geographically bounded synthesis that returns to the primary ethnobotanical evidence. National compilations may combine records from distant regions, place toothache together with broader oral indications, or repeat a taxon–use association from a secondary citation without re-examining the species-use table in the original survey [2,12,13].

Three related gaps therefore remain in the available literature. First, there is no focused synthesis of source-verified ethnobotanical evidence specifically from the Southern-Iran provinces examined in the present study. Second, direct reports of toothache or dental pain are often considered together with broader oral applications, making it difficult to distinguish pain-related evidence from gingival, infectious, hygienic, or other oral uses. Third, previous syntheses have not systematically integrated taxonomic identity, reported indication, and geographic location

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within a single analytical framework capable of examining both cross-study replication and geographic variation in reported use.

That distinction is consequential. A plant reported for gingivitis, dental infection, cleaning teeth, or strengthening the gums belongs to the wider ethnomedicine of oral care, but these indications are not equivalent to a record explicitly describing toothache or dental pain. The reverse problem can also occur: a survey restricted to oral disorders may report an analgesic effect without repeating the word "toothache" in every species row. A defensible synthesis therefore requires attention to the wording and context of the original record rather than a simple keyword count. More generally, the credibility of ethnopharmacological evidence depends on transparent documentation of plant use, botanical identification, voucher information where available, and a traceable relationship between the taxon and the reported indication [14].

The present study was designed to address these methodological and evidentiary gaps. We systematically examined published ethnobotanical evidence from a predefined Southern Iranian region comprising Fars, Hormozgan, Bushehr, and Khuzestan. Explicit toothache and clearly oral-analgesic records were separated from broader dental and oral uses; plant names were retained as reported and then reconciled against current nomenclature; and neighbouring provinces were used only for contextual comparison. Regional analysis considered not only whether a taxon recurred, but also whether its reported indication or mode of use varied across localities. AI-assisted procedures were used to support literature matching, nomenclatural screening, structured coding, and the identification of candidate taxon–indication–geography patterns, while every candidate pattern retained for interpretation was manually verified against the underlying published evidence. The aim was to identify medicinal taxa reported for toothache and oral pain within the available published ethnobotanical evidence from Southern Iran and to examine their cross-study replication, geographic patterning, preparation and administration practices, geographic variation in reported indications, and the traceability and reporting quality of the supporting evidence.

## Materials and Methods

### Study design and geographic scope

This study was conducted as a systematic review with qualitative thematic synthesis of published ethnobotanical and ethnopharmacological evidence. Reporting was organised with reference to PRISMA 2020 [15]. The qualitative synthesis followed the approach of Thomas and Harden, which moves from source-level coding to descriptive themes and, where supported by the evidence, to higher-level analytical interpretation [16]. ENTREQ was used as an additional guide for transparent reporting of qualitative evidence synthesis [17].

No new fieldwork was undertaken. The study did not recruit informants, conduct interviews or focus groups, collect plant material, or generate new voucher specimens. At study level, the evidentiary unit was the published report; at extraction level, it was the plant-use record traceable to that report.

The primary geographic region was defined before the final synthesis as Fars, Hormozgan, Bushehr, and Khuzestan. These provinces formed the denominator for the main Southern-Iran analysis. Comparator regions were not prespecified; relevant, recoverable primary studies outside Southern Iran with source-verifiable dental/oral evidence were retained when identified during literature searching or citation tracing. Comparator evidence was contextual rather than systematic or exhaustive and did not affect primary Southern-Iran counts.

The analytic framework treated each eligible record as a linked set of taxon, reported indication, province/locality, plant part, preparation method, administration route, and source context. This preserved the contextual nature of ethnobotanical knowledge and allowed two related questions to be examined separately: whether a taxon was replicated across independent studies and whether its reported indication or mode of use varied across

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geographic settings. The framework was consistent with the emphasis in ethnopharmacological reporting on explicit plant–use relationships and with the use of cross-study coding to develop descriptive and analytical themes [14,16]. Accordingly, geographic differences in the retrieved records were interpreted as differences in the available published evidence and not as estimates of the prevalence or distribution of traditional practices within the underlying communities.

## Literature search and source tracing

Literature identification continued until 25 September 2026. The documented search process included PubMed and PubMed Central, direct searching of journal and publisher websites, supplementary scholarly web searching, accessible full-text repositories, and backward and forward citation tracing from relevant primary studies and reviews. Reviews were used primarily to identify older, locally published, or otherwise difficult-to-locate field surveys; whenever a primary report containing species-level evidence could be recovered, the primary source rather than the secondary citation was used for eligibility assessment and data extraction. The documented search process did not include direct database searches of Scopus, Web of Science, or Embase, and these databases were therefore not retrospectively reported as searched. Their omission is considered a limitation of database coverage and is acknowledged in the limitations of this review.

Searches combined terms representing three concept groups: the target oral condition, the ethnobotanical or ethnopharmacological context, and geographic location. English search terms included “toothache,” “tooth pain,” “dental pain,” “oral pain,” “tooth,” “dental,” “gum,” “gingivitis,” “oral,” “medicinal plant,” “ethnobotany,” “ethnopharmacology,” “traditional medicine,” “Iran,” “Southern Iran,” “Fars,” “Shiraz,” “Hormozgan,” “Bushehr,” and “Khuzestan.” Persian equivalents of toothache, tooth, gum, mouth, and dental infection were additionally used when Persian-language articles or tables were searched or screened. Search terminology was therefore applied in English and Persian; no systematic search strategy in additional languages was documented.

Search methods were reported according to the information sources and search routes actually used during evidence acquisition; databases or search platforms that had not been searched directly were not added retrospectively. Where the original platform-specific search history was available, the corresponding search terms and search date were retained for supplementary reporting. The documented search routes, available search terms, and preserved search dates are summarized in Supplementary Table S1. Exact historical query strings or source-specific retrieval counts that had not been preserved were not retrospectively reconstructed or estimated. When a potentially relevant article cited in a review could not be recovered directly from its journal platform, additional source tracing used the article title, author names, DOI where available, journal details, and other bibliographic information to locate the original report.

Screening did not stop at the abstract. Relevant dental uses were sometimes confined to species tables, supplementary material, Results paragraphs, or Discussion text. Full-text retrieval and source tracing therefore remained part of eligibility assessment whenever the abstract alone could not establish the plant–indication relationship.

## Study selection and PRISMA reporting

Study selection followed the prespecified eligibility criteria and the PRISMA 2020 framework [15]. A cumulative evidence register was maintained throughout the review process. After final reconciliation, 63 records had been identified through the documented search and source-tracing routes. One exact duplicate was removed, leaving 62 unique reports for screening.

Of the 62 unique reports screened, 35 were excluded before full-text eligibility assessment: 19 were geographic comparator studies outside the

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primary Southern-Iran synthesis, 9 were reviews or other secondary sources, 3 were mechanistic or non-field studies, and 4 were methodological or reporting references. The remaining 27 reports underwent full-text or source-level eligibility assessment. Twelve reports were excluded at this stage because they did not meet the final eligibility requirements for the main Southern-Iran synthesis. Study-specific reasons for these exclusions are provided in Supplementary Table S2. Ultimately, 15 reports representing 14 independent primary studies were included in the main synthesis. The complete study-selection pathway, including duplicate removal, screening, full-text assessment, exclusions, and final study inclusion, is shown in Figure 1 [15].

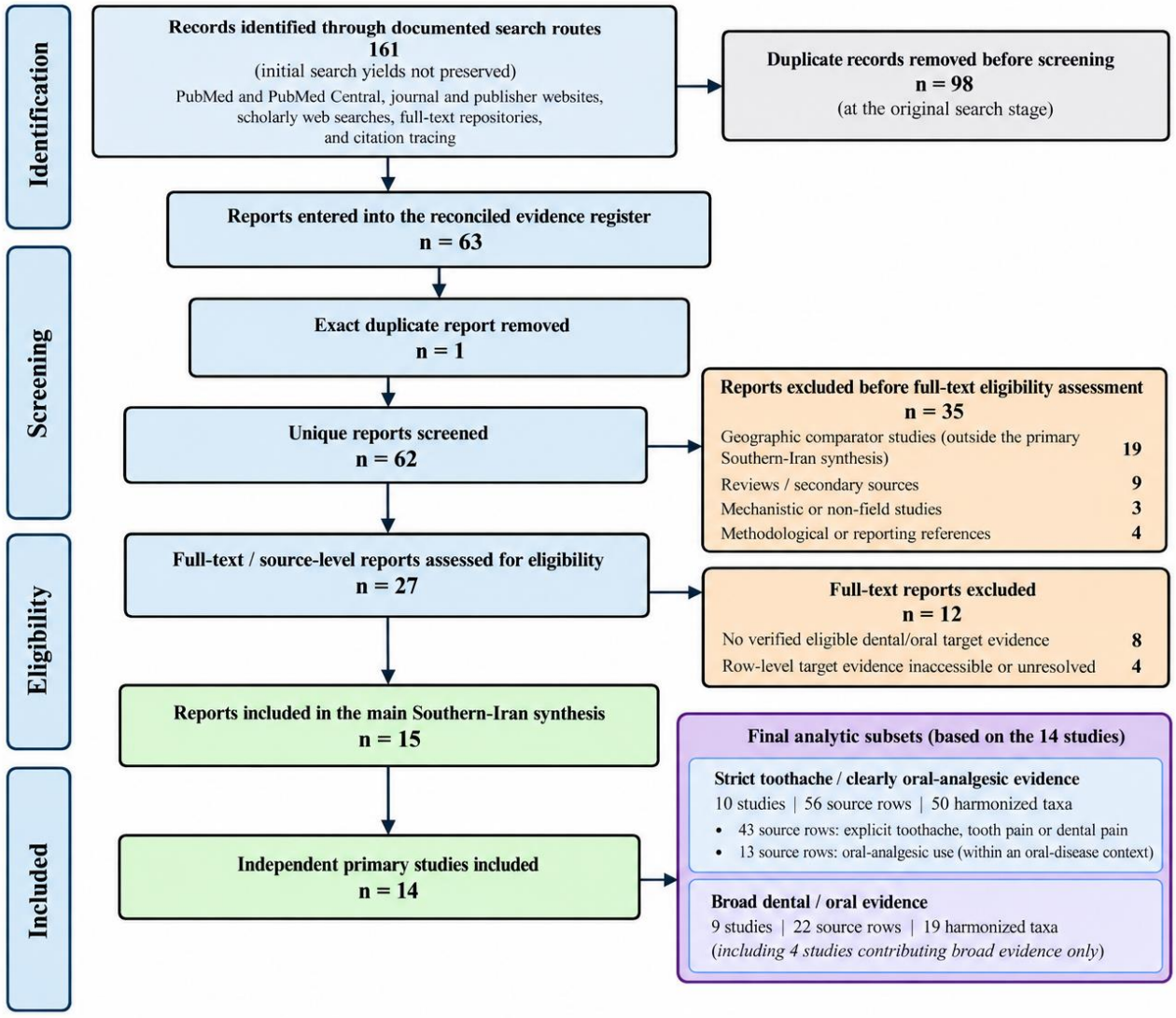


**Figure 1. PRISMA 2020-aligned evidence-selection flow**

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### Eligibility criteria and evidence classification

Eligible primary evidence consisted of ethnobotanical or ethnopharmacological reports conducted in the four predefined Southern-Iran provinces and containing a source-confirmed plant-use record relevant to toothache, dental pain, oral analgesia, or a related dental/oral indication. Species-level extraction required an identifiable scientific taxon. Genus-level evidence was retained at genus level when the source did not justify identification to species. For classification, records were assigned to four hierarchically defined evidence categories nested within the three analytic layers used for synthesis.

The strict toothache/oral-analgesic layer comprised two explicitly distinguished evidence categories. Category 1, direct toothache/dental-pain evidence, included records explicitly associated with toothache, tooth pain, dental pain, or a direct equivalent. Category 2, oral-context analgesic evidence, included analgesic records only when the study itself was explicitly restricted to oral disease and the taxon was directly linked to an analgesic effect. This criterion was applied to the Fars oral-disease survey of Zia-Behbahani et al. [7]. Oral-context analgesic evidence was retained within the strict analytic layer but was not interpreted as direct evidence of traditional use specifically for toothache. A general analgesic use reported outside an oral or dental context did not qualify for either of these two categories.

Category 3, broader dental/oral evidence, included records concerning dental infection, gingivitis, gingival inflammation or bleeding, gum tonics, oral thrush, stomatitis, mouth wounds, mouthwash, tooth cleaning, toothbrush or toothpick use, mouth freshening, and comparable oral-care practices. These observations were retained in the broad dental/oral layer but were never recoded as direct toothache/dental-pain or oral-context analgesic evidence.

Category 4 comprised general medicinal or contextual evidence without a specific qualifying oral indication. This contextual layer retained study-level information such as species richness, informant characteristics, dominant medicinal families, commonly used plant parts, preparation patterns, disease categories, and source-specific ethnobotanical indices when a qualifying species-level dental/oral record was absent or not fully recoverable.

This four-category hierarchy was maintained within the strict, broad, and contextual analytic layers throughout extraction and analysis, allowing the wider ethnomedical context of oral care to be retained without conflating direct toothache/dental-pain evidence with oral-context analgesia, other dental/oral applications, or general medicinal use [5–14].

### Full-text screening and source-level data extraction

Screening, full-text eligibility assessment, source verification, and data extraction were conducted by the single author. No independent second reviewer was involved in these stages; this single-reviewer workflow is acknowledged as a methodological limitation of the review.

Each potentially eligible primary report was screened according to a fixed hierarchy. Species-use tables and supplementary tables were examined first. When relevant information could not be recovered from them, the Results section was screened, followed by the Discussion, Conclusion, and other text containing ethnobotanical information.

Within searchable documents, candidate passages were located using terms including *toothache*, *tooth*, *teeth*, *dental*, *gum*, *gingivitis*, *mouth*, and *oral*, together with Persian equivalents where appropriate. Failure to retrieve a keyword was not interpreted as absence of evidence when a relevant table was image-based, incomplete, or inaccessible.

For each eligible plant-use record, we extracted the scientific name reported in the source, harmonized scientific name, family, vernacular name where available, province and locality, plant part, preparation, administration method, exact

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indication, frequency or number of reports, relevant ethnobotanical indices, voucher or herbarium information, and the location of the evidence within the source. Study-level contextual data were extracted separately.

Indication wording was preserved rather than normalized into a broader diagnostic category. Thus, "dental infection" remained a broad oral record rather than being recoded as toothache. Conversely, a clearly oral analgesic record was not discarded simply because the species row used "analgesic" rather than repeating "toothache".

This source-level procedure also allowed claims inherited from review articles to be tested against the reports from which they originated. Primary-table verification occasionally recovered records omitted by later summaries or showed that a taxon had been assigned a different indication in the original survey. Such discrepancies were retained in the audit trail rather than silently reconciled [12–14].

### Taxonomic harmonization and AI-assisted analytical workflow

Taxonomic checking followed extraction of the original source record. The scientific name used by the study authors was retained even when it represented an older synonym, historical family assignment, or variant author citation. A separate field recorded the final harmonized taxon.

Names were checked principally against Plants of the World Online, with World Flora Online, the International Plant Names Index, and Medicinal Plant Names Services used when additional nomenclatural confirmation was required [18–21]. Harmonization addressed spelling, synonyms, author citations, and historical family assignments. It was not treated as re-identification of the original botanical specimen.

A source identification was not replaced solely because its present-day geographic distribution appeared unusual for the reported locality. Such cases were retained with a taxonomic or geographic caution. This distinction prevented nomenclatural verification from being confused with specimen-level botanical identification.

AI-assisted processing was used only as a supporting analytical tool for literature matching, spelling and synonym screening, organization of extracted fields, preliminary coding, and identification of candidate taxon–indication–geography correspondences. Inputs consisted of bibliographic information, source-extracted plant-use records, reported taxon names, indication wording, locality information, and related structured extraction fields. Outputs were limited to candidate matches, suggested synonym or spelling correspondences, structured comparisons, and flags for records requiring further manual review. AI was not used to generate missing ethnobotanical data, establish botanical identity, or independently determine study eligibility or final evidence classification.

All consequential AI-assisted outputs were manually checked against the underlying published source. Taxonomic correspondences were additionally verified against authoritative botanical resources before acceptance [16,18–21]. Candidate indication or recurrence patterns were retained only when the relevant source-level records independently supported them. When an AI-assisted suggestion conflicted with the primary source or could not be verified, the suggestion was rejected and did not enter the final synthesis. Thus, the evidentiary decision remained source-based and human-verified throughout the workflow.

The historical project record preserved the tasks performed by AI and the associated source-verification procedure, but it did not retain a complete contemporaneous log of the specific AI model/version, platform configuration, exact dates of individual AI interactions, or verbatim prompts. These details are therefore not retrospectively reconstructed. These limits exact computational reproducibility of the AI-assisted component, although the substantive analytical decisions remain reproducible from the source-level evidence, extraction fields, taxonomic authorities, and documented eligibility rules.

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Representative task templates, examples of candidate synonym matching, indication classification, accepted and rejected AI-assisted suggestions, and the corresponding human-verification steps are provided in Supplementary Table S3. Recent evidence-synthesis research similarly supports the use of AI as an assisting rather than autonomous evidence source when expert verification is retained [22,23].

## Quality appraisal

Reporting quality and evidence documentation were assessed for each independent study included in the main Southern-Iran synthesis. The appraisal was designed to evaluate the completeness and traceability of reporting rather than the internal validity or risk of bias of the original studies. It was informed by the recommendations of Weckerle et al. for ethnopharmacological field research, including clear study design, transparent plant-use documentation, botanical identification, voucher traceability, and appropriate analysis [14].

Ten domains were assessed: study frame, informants and sampling, data-collection procedure, ethics or consent reporting, botanical identification, voucher or herbarium documentation, explicit taxon–indication linkage, reporting of plant part and preparation/administration, quantitative use information, and overall traceability of the evidence.

Each domain received 0, 1, or 2 points according to predefined reporting criteria. A score of 0 indicated that the relevant information was not demonstrated in the retained source and did not imply that the procedure had necessarily been omitted in the original field study. Total scores of 16–20 were classified as high reporting quality, 11–15 as moderate reporting quality, and 0–10 as limited reporting quality. The complete domain-specific criteria for assigning scores of 0, 1, and 2 are provided in Supplementary Table S4.

The scoring framework was a project-specific assessment of reporting and evidence documentation and was not treated as a validated risk-of-bias instrument. Accordingly, the resulting categories describe reporting completeness and traceability rather than methodological validity or absence of bias in the original studies [14].

To examine whether the principal strict-evidence findings were sensitive to reporting quality, a sensitivity analysis was conducted by repeating the strict synthesis after restricting the dataset to studies classified as having high reporting quality (score 16–20). The restricted analysis was compared with the full strict dataset with respect to the number of contributing studies, source rows, harmonized taxa, botanical families, and taxa replicated across two or more independent studies.

## Quantitative descriptive synthesis

No statistical meta-analysis was performed. The principal measure of cross-study replication was the number of independent eligible primary studies reporting each harmonized taxon. This measure was used to describe replication within the retrieved published evidence and was not interpreted as the prevalence or rarity of traditional use within communities. Cross-study replication was considered more interpretable than pooling ethnobotanical indices derived from surveys with different sampling strategies and denominators.

Use Value, Relative Frequency of Citation, Fidelity Level, Informant Consensus Factor, Cultural Importance, and related measures were retained in their original study-specific form. They were compared descriptively only when their definitions and denominators were sufficiently similar. Heterogeneous indices were not mechanically averaged.

Cross-study replication and geographic variation were examined at several linked levels: taxon across independent studies, taxon across provinces, and taxon across reported indications. The third comparison was used to describe geographic variation in reported indication—for example, cases in which the same harmonized taxon was associated with toothache in one locality

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but with gingival care, oral hygiene, or another oral indication elsewhere. These comparisons were descriptive and were not interpreted as evidence of temporal change, cultural causation, or ecological causation unless such an explanation was supported by the original reports [5–11].

Strict toothache/oral-analgesic evidence, broad dental/oral evidence, and comparator records were always analyzed separately. Replication observed in comparator studies was used only to support contextual interpretation and could not alter the primary Southern-Iran counts.

### Qualitative thematic synthesis

The qualitative synthesis followed the logic of Thomas and Harden [16]. Extracted evidence was initially coded close to the source material. Codes captured indication, plant part, preparation, administration route, within-region reporting, cross-study replication, geographic variation in reported indications, broader oral-care practices, taxonomic inconsistencies, and limitations in source reporting.

Related codes were subsequently organised into descriptive themes. Analytical interpretation was developed only after these themes had been compared across studies. This step was used to examine relationships among the elements of the conceptual framework, particularly whether cross-study replication was accompanied by consistency or variation in reported indications, whether similar practices were reported across geographically distinct studies, and where reported therapeutic uses differed among localities.

The purpose was not to infer beliefs or cultural mechanisms that the original studies had not documented. When a regional difference could plausibly reflect plant availability, transmission of local knowledge, cultural practice, or methodological differences between surveys, these possibilities were treated as interpretations requiring caution rather than as findings established by the dataset.

The final themes were repeatedly checked against the source-level extraction tables. Comparator evidence was used as a form of source and regional triangulation, especially when a taxon appeared with different dental or oral indications in neighboring provinces, but remained analytically separate from the primary Southern-Iran dataset. This movement from source-level coding to descriptive and analytical themes is consistent with the thematic-synthesis method, while ENTREQ informed transparent reporting of how interpretations were developed [16,17].

### Ethical considerations

The review used previously published material only. No new participants were recruited, no identifiable individual-level data were collected, and no new plant specimens were obtained. Accordingly, the present study involved no new participant recruitment or collection of identifiable individual-level data; any requirement for ethics review was subject to the applicable institutional and jurisdictional policies for secondary research.

Ethical approvals, consent procedures, and plant-collection permits reported in the original field studies were treated as characteristics of those studies and were not attributed to the present review.

## Results

### Study selection and characteristics of the included evidence

Following final reconciliation of the evidence register, 62 unique reports were available for eligibility assessment. Fifteen reports representing 14 independent primary studies met the criteria for the main Southern-Iran synthesis. The studies were published between 2013 and 2026 and covered all four predefined provinces. Seven independent studies were conducted in Fars, three in Khuzestan, two in Hormozgan, and two in Bushehr. One southern Fars cohort was represented by a peer-reviewed article and a companion report; these were linked and treated as one study rather than independent evidence.

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Ten studies contributed at least one strict toothache or clearly oral-analgesic record. Four additional studies contributed only to the broader dental/oral layer. Broad oral evidence was also present in five of the strict-contributing studies, giving nine studies with at least one broad dental or oral record overall. Across the 14 included independent studies, the study-level contributions shown in Table 1 account for 56 strict source rows and 22 broad dental/oral source rows, consistent with the totals used throughout the synthesis.

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**Table 1. Characteristics and evidence contribution of the 14 independent studies included in the main Southern-Iran synthesis**

| Authors/year | Province/locality | Study design | Informants (n) | Taxa reported (n) | Voucher/herbarium status | Ethics/consent reporting | Strict rows | Broad rows | Reporting-quality score/band |
|---|---|---|---|---|---|---|---|---|---|
| Ahmadipour et al., 2015 [4] | Fars, Shiraz | Field ethnobotanical study focused on toothache | 27 | 20 | Not demonstrated in retained source | Not demonstrated in retained source | 20 | 0 | 14/20; Moderate reporting quality |
| Zia-Behbahani et al., 2025 [7] | Fars, province-wide | Large-scale field ethnopharmacological oral-disease survey | 1,944 | 24 | Traceable vouchers/herbarium | Formal ethics/consent reported | 13 | 0 | 20/20; High reporting quality |
| Jafarirad & Damanafshan, 2017 [24] | Fars, Darab | Quantitative ethnobotanical study | 40 | 52 | Partial/study-level documentation | Not demonstrated in retained source | 2 | 3 | 15/20; Moderate reporting quality |
| Sohrabi-Akbarabadi & Khosravi, 2022 [25] | Fars, Akbarabad/Kavar | Quantitative ethnobotanical field study | 19 | 72 | Traceable voucher/herbarium deposition | Not demonstrated in retained source | 5 | 0 | 18/20; High reporting quality |
| Moein et al., 2015 [26] | Fars, Darab | Field-based ethnopharmacological report | NR | 58 | Traceable voucher documentation | Not demonstrated in retained source | 1 | 1 | 16/20; High reporting quality |
| Dolatkhahi et al., 2014 [6] | Fars, Arjan–Parishan | Field ethnobotanical study | 80 | 85 | Traceable voucher/herbarium documentation | Not demonstrated | 0 | 5 | 16/20; High reporting quality |

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| Authors/year | Province/locality | Study design | Informants (n) | Taxa reported (n) | Voucher/herbarium status | Ethics/consent reporting | Strict rows | Broad rows | Reporting-quality score/band |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | in retained source | | | |
| Ghafouri et al., 2025 [8] | Fars, Lar–Gerash–Lamerd | Quantitative ethnobotanical study | 200 | 171 | Partial/study-level specimen documentation | Formal ethics/consent reported | 0 | 1 | 19/20; High reporting quality |
| Safa et al., 2013 [5] | Hormozgan, province-wide | Field ethnobotanical study | NR | 150 | Traceable herbarium/specimen documentation | Not demonstrated in retained source | 7 | 3 | 15/20; Moderate reporting quality |
| Hosseini et al., 2026 [11] | Hormozgan, Minab–Rudan | Quantitative ethnobotanical field study | NR | 118 | Traceable study-level voucher/herbarium system | Partial ethics/consent reporting | 1 | 3 | 19/20; High reporting quality |
| Razmjoue et al., 2018 [9] | Khuzestan, Behbahan | Field ethnobotanical study | NR | 60 | Traceable herbarium identifiers | Not demonstrated in retained source | 1 | 3 | 16/20; High reporting quality |
| Khodayari et al., 2015 [10] | Northeastern Khuzestan | Field ethnobotanical study | NR | 174 | Traceable study-level herbarium documentation | Not demonstrated in retained source | 5 | 0 | 15/20; Moderate reporting quality |

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| Authors/year | Province/locality | Study design | Informants (n) | Taxa reported (n) | Voucher/herbarium status | Ethics/consent reporting | Strict rows | Broad rows | Reporting-quality score/band |
|---|---|---|---|---|---|---|---|---|---|
| Baroonian & Khodayari, 2023 [29] | Khuzestan, Susan district | Field ethnobotanical study | 80 | 109 | Partial/study-level documentation | Partial ethics/consent reporting | 1 | 0 | 16/20; High reporting quality |
| Khazaei et al., 2022 [27] | Bushehr, North/West Dashtestan | Field ethnopharmacological study | NR | NR | Traceable voucher/herbarium documentation | Partial ethics/consent reporting | 0 | 2 | 19/20; High reporting quality |
| Abolzadeh et al., 2020 [28] | Bushehr, Tangestan | Primary ethnopharmacological field study | NR | NR | Traceable voucher/herbarium documentation | Not demonstrated in retained source | 0 | 1 | 16/20; High reporting quality |

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NR, not reported or not reliably recoverable from the retained source material. "Not demonstrated in retained source" indicates absence of explicit documentation in the accessible report and does not imply that the procedure was not undertaken. Reporting-quality categories reflect the project-specific reporting and evidence-documentation appraisal and should not be interpreted as validated risk-of-bias categories.

## Reporting and evidence quality

Reporting-quality scores ranged from 14 to 20, with a mean of 16.7/20 and a median of 16/20. Ten studies had high reporting quality and four had moderate reporting quality; none were classified as limited. These categories reflect reporting completeness rather than validated risk of bias.

The strongest and most consistent domains were definition of the study setting, description of data-collection procedures, explicit taxon–indication linkage, and evidence traceability; all 14 studies received the maximum score in these domains. Botanical identification and voucher/herbarium documentation were also generally well reported.

The main weakness was ethics and consent reporting. Nine studies did not demonstrate an ethics or consent statement in the retained report, three provided partial documentation, and only two provided full documentation under the scoring framework. Quantitative ethnobotanical reporting was also variable: seven studies provided detailed quantitative information, whereas seven offered only partial quantitative measures.

Importantly, a score of zero in a domain indicated that the item was not demonstrated in the accessible publication, not that it had necessarily been omitted during the original fieldwork. Sensitivity analysis restricted to six strict-contributing studies with high reporting quality retained 22 strict rows, 20 harmonized taxa, and 11 families. Nineteen taxa remained single-study observations, while Solanum nigrum was the only taxon replicated across multiple studies. Thus, limited cross-study replication remained the dominant pattern. Figure 2 shows the study-level reporting-quality scores.

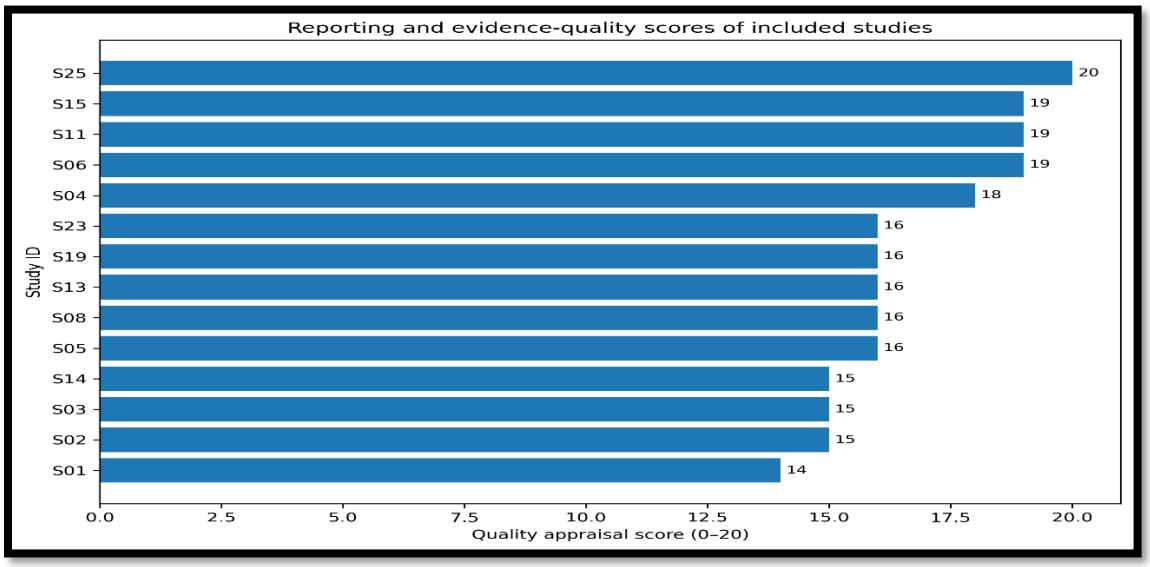


**Figure 2. Study-level reporting-quality scores of the 14 independent studies included in the main Southern-Iran synthesis. Scores range from 0 to 20: high reporting quality = 16–20, moderate = 11–15, and limited = 0–10.**

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### Strict toothache and oral-analgesic evidence

The final strict dataset contained 56 qualifying source rows from 10 independent studies, representing 50 harmonized taxa from 24 botanical families. Forty-nine taxa were resolved at species level; one record remained at genus level because the primary source did not support species-level identification.

Of the 56 strict rows, 43 (76.8%) explicitly referred to toothache, tooth pain, or an equivalent dental-pain indication. The remaining 13 rows (23.2%) came from the Fars oral-disease survey and were retained because the study was explicitly confined to oral diseases and linked those taxa directly to an analgesic effect [7]. This distinction was preserved throughout the analysis rather than treating all 56 records as literal occurrences of the word *toothache*.

The retrieved evidence was geographically uneven. Fars contributed 41 of 56 source rows (73.2%), representing 39 strict taxa across five studies; Hormozgan contributed eight rows from two studies and Khuzestan seven from three. No source-confirmed strict toothache record was retrieved from Bushehr, although broad oral/dental uses were documented; this absence should not be interpreted as evidence that such traditional use does not occur there.

This distribution is shown in Figure 3. The counts represent extracted evidence rows and should not be interpreted as provincial prevalence estimates.

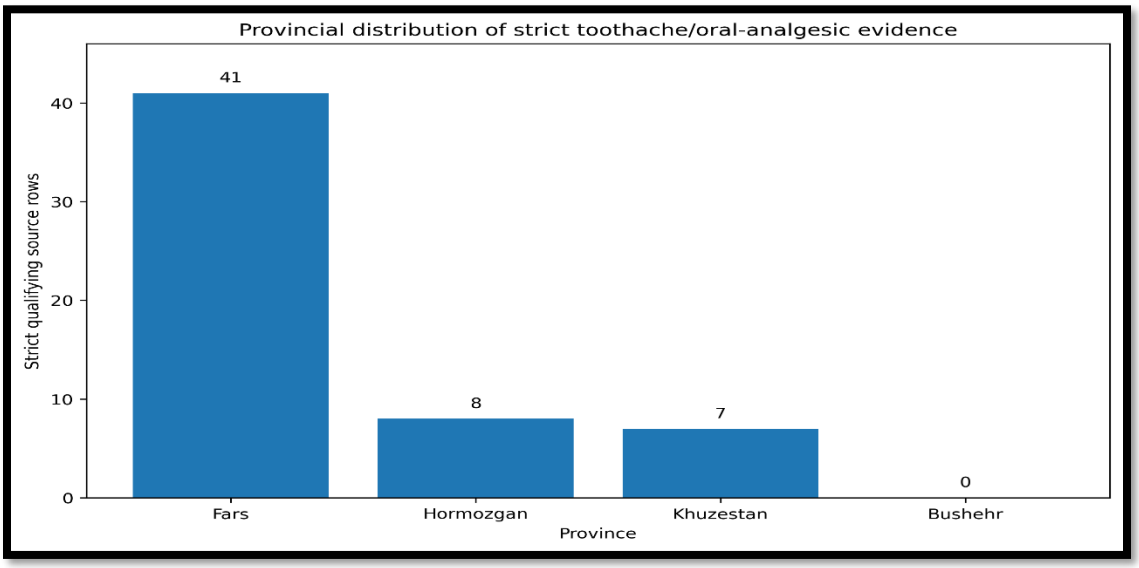


**Figure 3. Provincial distribution of strict toothache/oral-analgesic evidence in Southern Iran. Bars indicate the number of qualifying source rows contributed by each province; these counts represent extracted evidence records and should not be interpreted as estimates of provincial prevalence.**

Taxonomic richness was concentrated in a limited number of families. Asteraceae contributed eight strict taxa (16%), followed by Lamiaceae with seven (14%), Apiaceae with five (10%), Solanaceae with four (8%), and Caryophyllaceae with three (6%). Together, these five families accounted for 27 of the 50 harmonized taxa (54%). Nineteen additional families contributed one or two taxa each. The family-level composition of the strict evidence set is summarized in Figure 4.

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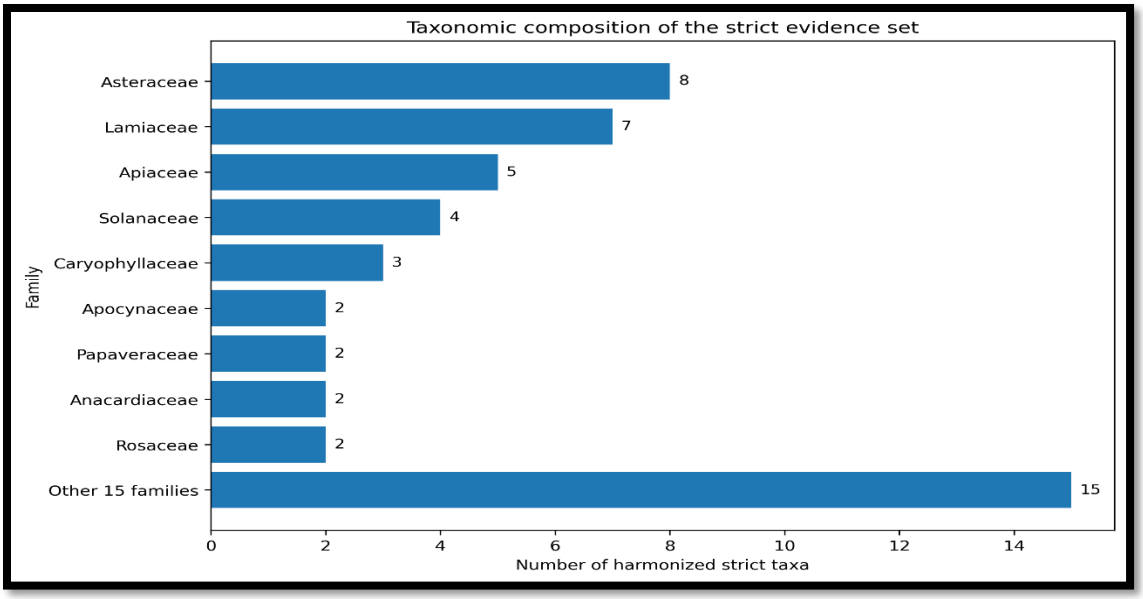


**Figure 4. Taxonomic composition of the strict toothache/oral-analgesic evidence set by botanical family. Bars indicate the number of harmonized strict taxa in each family. Families represented by a single taxon are grouped under "Other 15 families."**

## Cross-study recurrence and recurrent taxa

Cross-study replication was limited: 47 of the 50 strict taxa (94%) were documented in only one included study, while three occurred in two or more studies. This pattern reflects limited replication in the published evidence and should not be interpreted as rarity of traditional use.

Solanum nigrum showed the strongest recurrence, appearing in four independent studies: Behbahan, northeastern Khuzestan, Susan district, and the Fars oral-disease survey. Its Khuzestan records explicitly concerned toothache or toothache relief, whereas the Fars record was classified as oral analgesia.

*Zataria multiflora* was reported for toothache in three studies from Fars and Hormozgan. Matricaria chamomilla was reported for toothache in one Fars study and for oral analgesia in another. These three taxa formed the small replicated subset of the strict published evidence.

**Table 2. Strict taxa replicated across independent Southern-Iran studies and their reported indications**

| Harmonized taxon | No. of studies | Geographic evidence | Exact reported indication(s) |
|---|---|---|---|
| Solanum nigrum L. | 4 | Fars; three Khuzestan studies | Toothache/toothache relief in Khuzestan; oral analgesia in Fars |
| Zataria multiflora Boiss. | 3 | Fars; Hormozgan | Toothache in all three strict-contributing studies |
| Matricaria chamomilla L. | 2 | Fars | Toothache in one study; oral analgesia in one study |

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The recurrence pattern among strict taxa is shown in Figure 5.

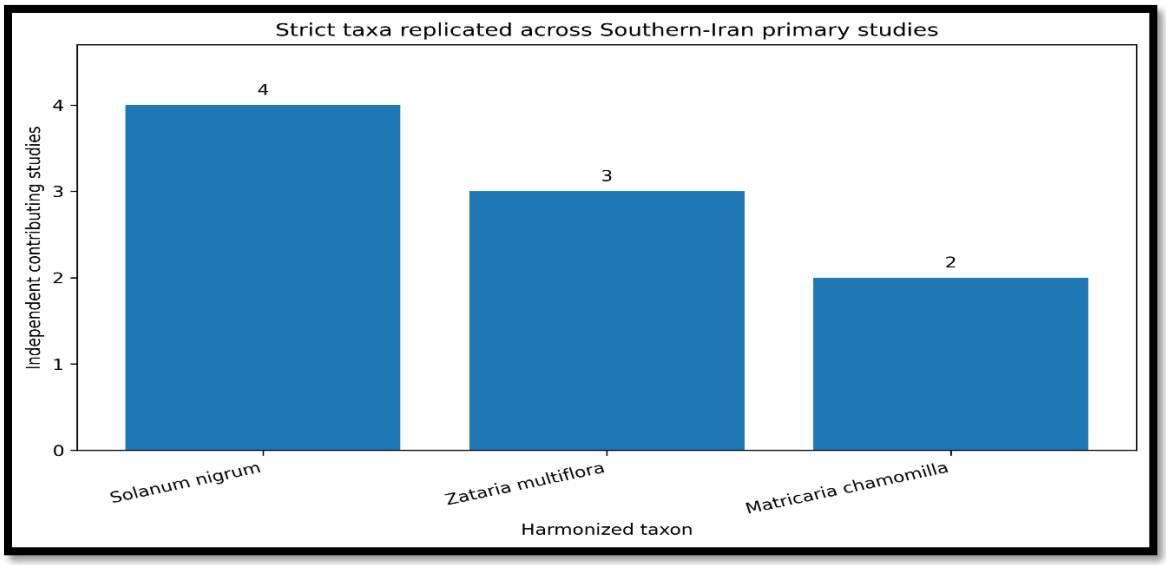


**Figure 5. Strict medicinal taxa reported in at least two independent Southern-Iran primary studies. Bars indicate the number of independent studies reporting each harmonized taxon; taxa reported in only one study are not shown.**

Study-specific quantitative measures were not pooled. For example, in the Shiraz study, *Dianthus hafezi* and *Papaver tenuifolium* each received 10 of 27 citations for toothache (37.03%), although the narrative text emphasized *P. tenuifolium*. In the 2025 Fars oral-disease survey, *Peganum harmala* had the highest number of oral-analgesic reports (n=6), followed by several taxa with smaller counts. These values were retained within their original study contexts rather than combined into a cross-study score.

## Plant parts and modes of preparation

Plant-part data were available for 55 of 56 strict rows and preparation data for 50. Because a record could include multiple plant parts or preparations, these categories were not mutually exclusive and mention counts could exceed the number of records.

Leaves or aerial parts occurred in 38 strict records, making them the most frequently represented plant material. Roots, stems, bark, or twigs occurred in 16 records; fruits or seeds in 14; flowers in 12; and gums, resins, or latex in four. Bulbs and whole-plant preparations were less frequent.

Decoction was the most frequently documented preparation, appearing in 30 strict records. Raw, fresh, unprepared, or crude use appeared in 13 records, while infusion or brew preparations appeared in nine. Paste, poultice, gum-based, or other direct local applications occurred in nine records. A smaller number involved smoke, fumigation, or inhalation.

These patterns show that traditional dental use was not restricted to orally consumed herbal preparations. Direct placement of plant material, chewing or gum application, fumigation, and smoke exposure also formed part of the documented therapeutic repertoire. Because some preparation fields were incomplete or not indication-specific, no pooled percentages were calculated; record-level taxon–part–preparation–administration–indication–province data are provided in Supplementary Table S5.

## Broad dental and oral-care evidence

The broad evidence layer contained 22 source rows representing 19 harmonized taxa from nine studies. These records were kept separate from the strict dataset.

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Fars contributed ten broad rows, Hormozgan six, and Bushehr and Khuzestan three each. The evidence covered several components of oral care rather than a single disease category. Gingival uses included gum bleeding, gingivitis, gum inflammation, gingival tonics, and gum infection. Other records concerned dental or oral infection, oral thrush, mouth wounds, mouthwash use, cleaning teeth, use as a toothbrush or toothpick, mouth freshening, and elimination of a reported "dental larva".

Three broad taxa were reported in more than one included study: *Ephedra pachyclada*, *Salvadora persica*, and *Plantago arenaria*; all others appeared in one study only.

**Table 3. Main components of the broad oral-care evidence layer**

| Oral-care domain | Representative harmonized taxa | Examples of reported uses |
|---|---|---|
| Gingival care | Dracocephalum royleanum, Bassia eriophora, Pistacia khinjuk, Salvadora persica, Plantago arenaria | Gum bleeding, gingivitis, gum tonic, gum infection |
| Oral/dental infection and inflammation | Cassia fistula, Ephedra pachyclada, Zataria multiflora, Anthemis cotula, Astragalus gossypinus | Oral thrush, mouth disease, dental infection, oral inflammation |
| Oral hygiene | Salvadora persica, Ammi majus, Astragalus fasciculifolius, Anthriscus nemorosus | Cleaning teeth, toothpick, toothbrush, mouth freshening |
| Other oral uses | Matricaria chamomilla, Juglans regia, Vitex agnus-castus, Ocimum basilicum | Mouth-and-tooth category, dental larva, mouth wound |

These domains are descriptive and are not mutually exclusive.

## Regional convergence and geographic variation in reported indications

The taxon–indication–geography analysis revealed cross-regional convergence and geographic variation in reported indications.

Comparator provinces contributed 29 verified direct-toothache source rows representing 19 harmonized taxa, together with 12 broad oral rows representing 10 taxa. Six taxa in the Southern strict dataset also appeared in direct-toothache comparator evidence: *Calotropis procera*, *Dianthus crinitus*, *Peganum harmala*, *Pistacia atlantica*, *Pistacia khinjuk*, and *Teucrium polium*.

Some taxa showed relatively stable recurrence. *Peganum harmala*, for example, appeared as an oral analgesic in Fars and as a direct toothache remedy in Kerman, Kohgiluyeh and Boyer-Ahmad, and Ilam. *Solanum nigrum* likewise showed repeated pain-related use across Fars and three Khuzestan studies.

Other taxa showed different reported indications across regions. *Pistacia khinjuk* appeared as an oral analgesic in Fars, a gingival tonic in Hormozgan, a toothache remedy in Kerman, and a mouth-freshening plant in Ilam. *Teucrium polium* was linked directly to toothache in northeastern Khuzestan and Kohgiluyeh and Boyer-Ahmad but

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to fragrant-mouth use or stomatitis in Ilam. *Astragalus fasciculifolius* was recorded as a toothbrush in southern Fars but for aching tooth in Kohgiluyeh and Boyer-Ahmad.

Within Bushehr, *Plantago arenaria* provided another example of local indication variability. Its verified dental records concerned gum infection in north/west Dashtestan and dental infection in Tangestan, whereas records from other Bushehr localities described non-dental uses such as abscess drainage or respiratory complaints.

**Table 4. Selected recurrent taxa illustrating convergence or geographic variation in reported indications**

| Taxon | Southern-Iran evidence | Comparator evidence | Observed pattern |
|---|---|---|---|
| Solanum nigrum | Toothache in three Khuzestan studies; oral analgesia in Fars | — | Strong pain-related recurrence |
| Zataria multiflora | Toothache in Fars/Hormozgan; dental/oral infection in Bushehr | — | Pain → infection-related oral use |
| Peganum harmala | Oral analgesia in Fars | Toothache in Kerman, K&B and Ilam | Cross-regional convergence |
| Pistacia khinjuk | Oral analgesia in Fars; gingival tonic in Hormozgan | Toothache in Kerman; mouth freshener in Ilam | Marked geographic variation |
| Teucrium polium | Toothache in Khuzestan | Toothache in K&B; oral/stomatitis uses in Ilam | Pain ↔ broader oral use |
| Astragalus fasciculifolius | Toothbrush in southern Fars | Aching tooth in K&B | Oral hygiene ↔ pain relief |
| Plantago arenaria | Gum/dental infection in Bushehr | — | Strong local indication variability |

Figure 6 summarizes selected taxon–indication patterns across the Southern-Iran and comparator evidence layers.

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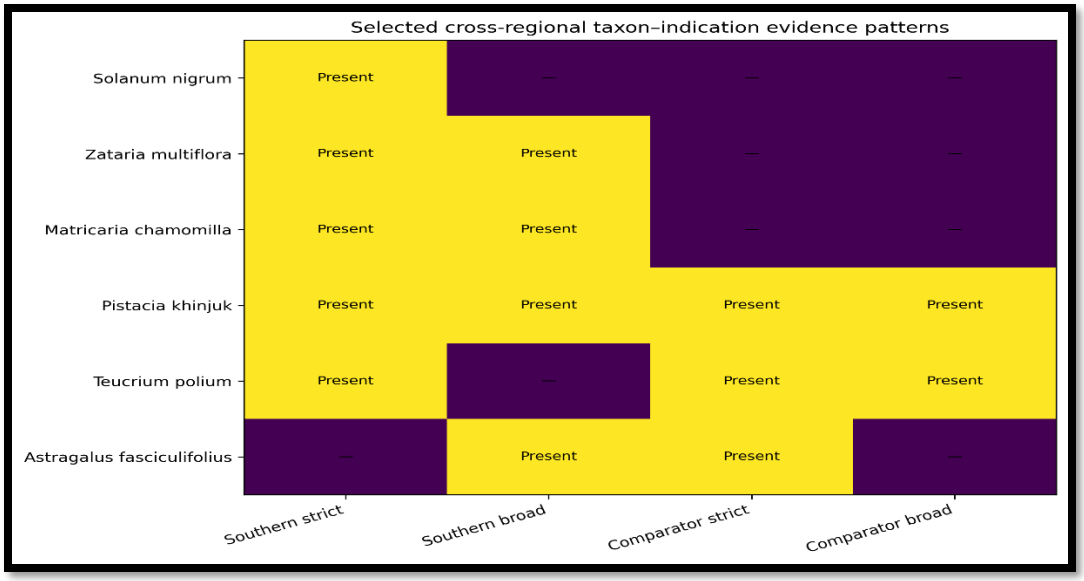


**Figure 6. Cross-regional taxon–indication patterns**

These patterns were treated descriptively. They indicate geographic variation in recorded ethnomedical use but do not by themselves identify whether the differences arise from cultural transmission, ecological availability, or variation in study design.

Figure 6. Selected cross-regional taxon–indication evidence patterns. Cells indicate the presence of a verified record within the Southern-Iran strict, Southern-Iran broad, comparator strict, or comparator broad evidence layers. The figure illustrates selected patterns of recurrence and geographic variation in reported indications and is not intended as an exhaustive representation of all taxa.

## Taxonomic reconciliation and source-level verification

Taxonomic harmonization materially altered the structure of the final evidence map. Source-reported names were retained, but accepted or harmonized names were used for cross-study recurrence analysis.

Several records that would otherwise appear as distinct taxa were consolidated. Examples included *Anthemis altissima* under *Cota altissima*, *Matricaria recutita* under *Matricaria chamomilla*, *Lallemantia royleana* under *Dracocephalum royleanum*, and *Otostegia persica* under *Rydingia persica*. Historical family assignments were also updated where appropriate without changing the source record. Record-level taxonomic actions and precise source locations are provided in Supplementary Table S5.

The AI-assisted matching layer was particularly useful for flagging candidate spelling, synonym, and cross-study taxon–indication correspondences. These candidates were not accepted automatically. Each consequential match was checked against the primary record and an authoritative botanical source before incorporation into the synthesis.

Source-level verification also changed the evidence register itself. The final reconciliation identified a missing bibliographic registration for the Akbarabad/Kavar study while confirming that its five strict rows had already been extracted. It also identified one exact duplicate report in the evidence register. In comparator evidence, primary-table checking corrected review-derived mappings where species had been assigned to toothache without support from the corresponding primary table.

The 2025 Fars oral-disease study was another consequential case: full-table review established that 13 taxa were directly associated with an

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analgesic effect within an explicitly oral-disease dataset. These records therefore entered the strict layer under the predefined eligibility rule rather than being left as generic contextual evidence.

**Final thematic synthesis**

Eight themes emerged after source-level coding and comparison across the strict, broad, and comparator layers.

**Table 5. Final thematic synthesis**

| Theme | Main evidence signal |
|---|---|
| 1. High diversity with low recurrence | 50 strict taxa, but 47 occurred in only one study |
| 2. A small recurrent core | Solanum nigrum, Zataria multiflora, and Matricaria chamomilla formed the only repeated Southern taxa |
| 3. Diverse preparation and delivery | Decoctions were common, but direct placement, crude use, gum/resin application, smoke and fumigation were also documented |
| 4. Toothache within a wider oral-care system | 22 broad oral rows extended from gingival care and infection to hygiene and tooth cleaning |
| 5. Geographic variation in reported indications | The same taxon was reported for different oral indications across regions |
| 6. Source verification changed the evidence map | Primary-table checking recovered eligible records, corrected secondary mappings and resolved duplicate/report-registration issues |
| 7. Nomenclatural harmonization altered apparent recurrence | Synonym resolution prevented artificial splitting of the same taxon across studies |
| 8. Ethnobotanical evidence is not clinical efficacy evidence | No included study provided controlled clinical evidence that the reported plants relieve toothache |

**Supplementary Material**

AI-Assisted Ethnobotanical Synthesis of Medicinal Plants Used for Toothache and Oral Pain in Southern Iran: A Systematic Review and Qualitative Analysis

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**Supplementary Table S1. Documented literature-search routes, available search terms, and preserved search dates**

| Information source/search route | Search date / period | Search focus / available terms | Status / notes |
|---|---|---|---|
| PubMed and PubMed Central | 25 September 2026 | Iran; Southern Iran; toothache; tooth pain; dental pain; oral pain; oral diseases; ethnobotany; ethnopharmacology; Fars; Shiraz; Hormozgan; Bushehr; Khuzestan | Used for literature identification, bibliographic verification, and accessible full-text/table retrieval where available. |
| Journal and publisher websites | 25 September 2026 | Title-, author-, journal-, DOI-, and topic-based searches for relevant ethnobotanical and oral-health reports | Used for primary-source retrieval and bibliographic verification. |
| Supplementary scholarly web/search routes | 25 September 2026 | Southern-Iran ethnobotany; toothache/dental pain/oral diseases; province- and locality-specific combinations | Used for discovery and source triangulation. Final eligibility and extraction decisions were based on recoverable source evidence. |
| Backward and forward citation tracing | Up to 25 September 2026 | Reference lists and citing literature of relevant primary studies and reviews | Used particularly to locate older, locally published, or difficult-to-retrieve primary reports. |
| Persian-language searching/screening | Up to 25 September 2026 | Persian equivalents of toothache, tooth, gum, mouth, dental infection, and related oral terms | Applied when Persian-language articles, tables, or searchable full text were available. |
| Scopus | Not searched directly | — | Not retrospectively reported as searched. |
| Web of Science | Not searched directly | — | Not retrospectively reported as searched. |
| Embase | Not searched directly | — | Not retrospectively reported as searched. |

**Note:** The retained historical search log did not preserve complete platform-specific query strings or numerical retrieval yields for the original identification stage. These data were therefore not retrospectively reconstructed or estimated. Search information is reported only where it could be supported by the preserved project record.

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**Supplementary Table S2. Southern-Iran primary reports excluded after full-text or source-level eligibility assessment and specific reasons for exclusion**

| Report | Province/locality | Specific reason for exclusion |
|---|---|---|
| Ethnobotanical study of medicinal plants, Fasa County, Iran | Fars (Fasa) | No verified eligible dental/oral target evidence after source-level screening. |
| Ethno-medicinal survey on weed plants in agro-ecosystems: a case study in Jahrom, Iran | Fars (Jahrom) | No verified eligible dental/oral target evidence after source-level screening. |
| Ethnopharmacology of Medicinal Plants in the South of Dashtestan Area | Bushehr (Dashtestan south) | Row-level dental/oral target evidence was unavailable or unresolved. |
| Systematically study of medicinal plants in Bushehr province, Southern Iran | Bushehr | Row-level dental/oral target evidence was unavailable or unresolved. |
| The Most Used Medicinal Plant Species of Dashtestan (Bushehr Province), with Emphasize on Their Traditional Uses | Bushehr (Dashtestan) | Searchable text and disease categories yielded no eligible dental/oral evidence; the image-heavy species table remained incompletely recoverable. |
| Ethnobotanical Study of Medicinal Plants Used in the Northeast Latrine Zone of Persian Gulf | Bushehr / northeastern Persian Gulf | No explicit eligible dental/oral signal was recovered from accessible text; row-level assessment was limited by imperfect source/OCR access. |
| Study of Herbal Medicine in Zirrah (Touz) /Dashtestan/Bushehr province | Bushehr (Zirrah/Touz, Dashtestan) | Row-level dental/oral status could not be verified from the accessible source material. |
| Ethnopharmacology of Medicinal Plants in the Kangan-Asaluyeh Area | Bushehr (Kangan-Asaluyeh) | No eligible dental/oral statement was found in accessible evidence; complete target-use row-level verification was unavailable. |
| Ethnopharmacology of the native herbs of Helleh River (Bushehr Province/Iran) | Bushehr (Helleh River) | No eligible dental/oral statement was found in accessible evidence; complete target-use row-level verification was unavailable. |
| Ethnopharmacology of Medicinal Plants in the Southwest of Mond Mountain | Bushehr (Southwest Mond Mountain) | No eligible dental/oral signal was identified in accessible indexed content; complete row-level verification remained unavailable. |

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| Report | Province/locality | Specific reason for exclusion |
|---|---|---|
| Ethnopharmacology of Medicinal Plants in the Giskan Mountain Area | Bushehr (Giskan Mountain) | No source-confirmed eligible dental/oral row was recovered from accessible material, and the species-use table remained unavailable. |
| Importance of Using Ethnobiological Knowledge for the Conservation of Medicinal Plants Biodiversity in the Lar Region (Iran) | Fars (Lar region) | Full text and species-level target-use evidence were not recoverable; no dental/oral inference was made without source verification. |

**Note:** These 12 reports were within the predefined Southern-Iran geography but did not contribute to the strict or broad evidence denominators. Two yielded no verified eligible dental/oral target evidence after source-level screening; for the remaining reports, target-use row-level evidence was inaccessible or unresolved. No missing row-level evidence was inferred or reconstructed.

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**Supplementary Table S3. Representative AI-assisted workflow templates, verification steps, and disposition of candidate outputs**

| Workflow task | Representative input | Representative AI-assisted output | Human verification | Final disposition |
|---|---|---|---|---|
| Taxonomic synonym matching | Source-reported name: Matricaria recutita L. | Candidate correspondence: Matricaria chamomilla L. | Checked against authoritative botanical nomenclature; source-reported name retained separately from harmonized name. | Accepted as a harmonization candidate after manual verification. |
| Taxonomic synonym matching | Source-reported name: Lallemantia royleana Benth. | Candidate correspondence: Dracocephalum royleanum Benth. | Checked against authoritative botanical nomenclature and the original source row. | Accepted as the harmonized name; original source name preserved. |
| Indication classification | A source row listed only within a broad 'Mouth and Tooth' category without a direct pain indication. | Candidate classification: possible toothache-related record. | Original table/context re-checked against the predefined evidence hierarchy. | Rejected as direct toothache evidence; retained only in the broad oral/dental layer when appropriate. |
| Oral-context analgesic classification | Analgesic use reported in a study explicitly restricted to oral diseases. | Candidate classification: oral-context analgesic evidence. | Verified against the source table and the prespecified Category 2 eligibility rule. | Accepted in the strict analytic layer but not interpreted as a literal toothache record. |
| Cross-study recurrence | Same or potentially synonymous taxon names occurring in multiple studies. | Candidate recurrence link across studies. | Each record checked against the primary source and harmonized taxonomy before counting independent-study recurrence. | Accepted only when source-level and taxonomic verification agreed. |
| Secondary-source discrepancy | A review attributed a taxon to toothache, but the corresponding primary table did not support that taxon–indication link. | Candidate toothache association from secondary literature. | Primary source table given priority over the later review. | Rejected from the strict evidence register when not supported by the primary source. |

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**Note:** The historical project record did not retain a complete contemporaneous log of the specific AI model/version, platform configuration, exact dates of individual AI interactions, or verbatim prompts. The examples above are representative task templates reconstructed from the documented workflow and audit trail; they are not presented as verbatim historical prompts or outputs.

**Supplementary Table S4. Exact 0/1/2 criteria for the project-specific reporting and evidence-documentation appraisal**

| Domain | Score 0 | Score 1 | Score 2 |
|---|---|---|---|
| Q1 Study frame | Not demonstrated | Partial locality/time/setting description | Study area, period and population frame clearly described |
| Q2 Informants/sampling | Not demonstrated | Partial informant or sampling detail | Sampling/informant characteristics adequately described |
| Q3 Data collection | Not demonstrated | Basic procedure only | Questionnaire/interview/field procedure clearly reproducible |
| Q4 Ethics/consent | Not reported in retained evidence | Partial ethics/consent statement | Formal ethics/consent/legal permission clearly reported |
| Q5 Botanical identification | Not demonstrated | Identification mentioned without clear qualified method/person | Identification method and/or qualified botanist clearly reported |
| Q6 Voucher/herbarium | No traceable specimen evidence | Study-level herbarium/specimen statement or incomplete voucher coverage | Traceable voucher/herbarium deposition or row-level specimen identifiers |
| Q7 Taxon–indication linkage | Ambiguous | Partly inferable/category-level | Eligible indication explicitly linked to a taxon/source row |
| Q8 Part/preparation/route | Not reported | Partially reported | Plant part plus preparation/route adequately documented |
| Q9 Quantitative use data | Absent | Limited counts/indices/denominator detail | Clear absolute counts and/or interpretable ethnobotanical indices |
| Q10 Traceability/limitations | Poor traceability | Partial source/data traceability | Full source/table traceability and limitations/overlap assessable |

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**Interpretation thresholds:** High reporting/evidence quality = 16–20; Moderate = 11–15; Limited = 0–10.

**Important note:** This is a project-specific reporting/evidence-quality appraisal informed by ethnopharmacological field-study reporting standards; it is not a validated risk-of-bias instrument. A score of 0 means that the item was not demonstrated in the retained source/evidence, not that the procedure definitely did not occur in the field.

**Primary methodological basis:** Weckerle et al. (2018), Recommended standards for conducting and reporting ethnopharmacological field studies, Journal of Ethnopharmacology, DOI 10.1016/j.jep.2017.08.018.

Supplementary Table S5. Record-level evidence matrix for the strict and broad Southern-Iran dental/oral evidence layers

**Scope:** 56 strict source rows plus 22 broad dental/oral source rows. NR = not reported or not reliably recoverable from the retained source material.

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| Evidence layer | Study ID | Study/source | Province/locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Achillea eriophora DC. | Achillea eriophora DC. | Genus/family reassigned | Toothache | Aerial parts | Decoction | Use count: 9; Frequency of citation (%): 33.33 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Amygdalus scoparia Spach. | Prunus scoparia (Spach) C.K.Schneid. | Synonymized | Toothache | Fruits and leaves | Decoction | Use count: 6; Frequency of citation (%): 22.22 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Salvia atropatana Bunge | Salvia atropatana Bunge | Unchanged | Toothache | Aerial parts | Decoction | Use count: 2; Frequency of citation (%): 7.4 | NR | Table 1 + Table 2 |
| Strict toothache/oral | S01 | Ahmadipour | Fars, Shiraz | Dianthus hafezi Assadi | Dianthus hafezi Assadi | Unchanged | Toothache | Aerial parts | Paste | Use count: 10; | NR | Table 1 + Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -analgesic | | et al., Shiraz | | | | | | | | Frequency of citation (%): 37.03 | | |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Matricaria recutita L. | Matricaria chamomilla L. | Synonymized | Toothache | Flowers and leaves | Decoction | Use count: 4; Frequency of citation (%): 14.81 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Ziziphora persica Bfe | Ziziphora persica Bunge | Spelling corrected | Toothache | Aerial parts | Decoction | Use count: 5; Frequency of citation (%): 18.51 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Amygdalus lycioides Spach. | Prunus lycioides (Spach) C.K.Schneid. | Synonymized | Toothache | Aerial parts | Paste | Use count: 6; Frequency of citation | NR | Table 1 + Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | (%): 22.22 | | |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Borago officinalis L. | Borago officinalis L. | Unchanged | Toothache | Flowers | Decoction | Use count: 6; Frequency of citation (%): 22.22 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Gundelia tournefortii L. | Gundelia tournefortii L. | Genus/family reassigned | Toothache | Stem and leaves | Paste | Use count: 4; Frequency of citation (%): 14.81 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Prangos acaulis (DC.) Bornm. | Prangos acaulis (DC.) Bornm. | Unchanged | Toothache | Aerial parts | Decoction | Use count: 7; Frequency of citation (%): 25.92 | NR | Table 1 + Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Centaurea deppressa M. | Centaurea depressa M.Bieb. | Spelling corrected | Toothache | Aerial parts | Decoction | Use count: 3; Frequency of citation (%): 11.11 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Acanthophyllum spp. | Acanthophyllum spp. | Unchanged | Toothache | Aerial parts | Decoction | Use count: 5; Frequency of citation (%): 18.51 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Nigella ciliaris L. | Nigella ciliaris DC. | Spelling corrected | Toothache | Seeds | Decoction | Use count: 7; Frequency of citation (%): 25.92 | NR | Table 1 + Table 2 |
| Strict toothache/oral- | S01 | Ahmadipour | Fars, Shiraz | Papaver tenuifolium | Papaver tenuifolium | Unchanged | Toothache | Flowers and leaves | Decoction | Use count: 10; Frequen | NR | Table 1 + Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| analgesic | | et al., Shiraz | | Boiss. & Hohen. | Boiss. & Hohen. | | | | | cy of citation (%): 37.03 | | |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Glaucium grandiflorum Boiss. & Huet. | Glaucium grandiflorum Boiss. & A.Huet | Spelling corrected | Toothache | Leaves | Decoction | Use count: 3; Frequency of citation (%): 11.11 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Cinnamomum verum J.Presl | Cinnamomum verum J.Presl | Unchanged | Toothache | Bark | Paste | Use count: 1; Frequency of citation (%): 3.7 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Zingiber officinale Roscoe | Zingiber officinale Roscoe | Unchanged | Toothache | Aerial parts and root | Paste | Use count: 5; Frequency of citation (%): 18.51 | NR | Table 1 + Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Haplophyllum perforatum L. | Haplophyllum acutifolium (DC.) G.Don | Synonymized | Toothache | Aerial parts | Paste | Use count: 1; Frequency of citation (%): 3.7 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Zataria multiflora Boiss. | Zataria multiflora Boiss. | Unchanged | Toothache | Leaves | Decoction | Use count: 6; Frequency of citation (%): 22.22 | NR | Table 1 + Table 2 |
| Strict toothache/oral-analgesic | S01 | Ahmadipour et al., Shiraz | Fars, Shiraz | Pyrethrum roseum M.Bieb. | Tanacetum coccineum subsp. coccineum | Synonymized | Toothache | Leaves | Decoction | Use count: 8; Frequency of citation (%): 29.62 | NR | Table 1 + Table 2 |
| Strict toothache/oral- | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Erodium cicutari | Erodium cicutari | Spelling corrected | Toothache | Root | Decoction | NR | Hormozgan herbarium | Table 1 row 57 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| analgesic | | | | um (L.) L'Her. | um (L.) L'Hér. | | | | | | | |
| Strict toothache/oral-analgesic | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Gailonia Aucheri Jaub. Spach | Plocama aucheri (Guill.) M.Backlund & Thulin | Synonymized | Toothache; rheumatism; flatuosity; diarrhea; gonalgia; gnathitis | Leaves, twig, flower | Fresh organ; brew | NR | Hormozgan herbarium | Table 1 row 65 |
| Strict toothache/oral-analgesic | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Hyoscyamus muticus Bornm. | Hyoscyamus muticus L. | Spelling corrected | Toothache | Seed | Smoke fumes | NR | Hormozgan herbarium | Table 1 |
| Strict toothache/oral-analgesic | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Rhazya stricta Decne. | Rhazya stricta Decne. | Unchanged | Bone pain; rheumatism; joint pain; toothache; eye pain | Leaves | Decoction; fresh organ | NR | Hormozgan herbarium | Table 1 row 112 |
| Strict toothache/oral | S02 | Safa et al., | Hormozgan, | Zataria multiflora Boiss. | Zataria multiflora Boiss. | Unchanged | Includes toothache | Leaves | Powder; brew; fresh organ | NR | Hormozgan | Table 1 row 144 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -analgesic | | Hormozgan | Province-wide | | | | | | | | herbarium | |
| Strict toothache/oral-analgesic | S03 | Jafarirad & Damanafshan, Darab | Fars, Darab | Anthemis altissima L. | Cota altissima (L.) J.Gay | Synonymized | Toothache | NR | NR | Use count: 22; Fidelity level (%): 55 | NR | Table 6 (oral/dental disorder) |
| Strict toothache/oral-analgesic | S04 | Sohrabi-Akbarabadi & Khosravi, Akbarabad | Fars, Akbarabad, Kavar | Echinophora platyloba DC. | Echinophora platyloba DC. | Unchanged | Tooth ache (1) | Aerial parts (17 use-reports) | Decoction (14); aromatic water (3) | Use count: 1; Use-report for toothache: 1 | 12 | Table 1 row 3 |
| Strict toothache/oral-analgesic | S04 | Sohrabi-Akbarabadi & Khosravi, Akbarabad | Fars, Akbarabad, Kavar | Echinops endotrichus Rech.f. | Echinops endotrichus Rech.f. | Unchanged | Toothache (1) | Cocoon on stem (20) | Decoction (20) | Use count: 1; Use-report for toothache: 1 | 183 | Table 1 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S04 | Sohrabi-Akbarabadi & Khosravi, Akbarabad | Fars, Akbarabad, Kavar | Allium cepa L. | Allium cepa L. | Genus/family reassigned | Toothache (1) | Bulb (11) | Raw (10); juice (1) | Use count: 1; Use-report for toothache: 1 | NR | Table 1 |
| Strict toothache/oral-analgesic | S04 | Sohrabi-Akbarabadi & Khosravi, Akbarabad | Fars, Akbarabad, Kavar | Dionysia revoluta Boiss. | Dionysia revoluta Boiss. | Unchanged | Toothache (1) | Aerial parts (15) | Decoction (15) | Use count: 1; Use-report for toothache: 1 | NR | Table 1 |
| Strict toothache/oral-analgesic | S04 | Sohrabi-Akbarabadi & Khosravi, Akbarabad | Fars, Akbarabad, Kavar | Solanum americanum Mill. | Solanum americanum Mill. | Unchanged | Toothache (1) | Fruit (16) | Raw (5); decoction (11) | Use count: 1; Use-report for toothache: 1 | 220 | Table 1 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S03 | Jafarirad & Daman afshan, Darab | Fars, Darab | Plantago major L. | Plantago major L. | Unchanged | Analgesic for toothache | Leaf | Unprepared | Use count: 9; Number of persons reporting row-level use: 9 | NR | Table 2, p.109 (PDF page 8) |
| Strict toothache/oral-analgesic | S08 | Moein et al., Darab | Fars, Darab | Zataria multiflora Boiss. | Zataria multiflora Boiss. | Unchanged | Astringent, expectorant / cough, toothache | Leaf | Infusion | Use report count not provided for this row | Voucher 409 | Table 1, p.41 (PDF page 2) |
| Strict toothache/oral-analgesic | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Pteropyrum Aucheri Jaub. & Spach | Pteropyrum aucheri Jaub. & Spach | Spelling corrected | Bone/hand/leg/knee pain; toothache; headache; back pain; wound healing; washing wounds | Leaves, flower, root, stem | Decoction; fresh organ | NR | Hormozgan herbarium | Table 1, row 108 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S02 | Safa et al., Hormozgan | Hormozgan, Province-wide | Vitex Negundo L. | Vitex negundo L. | Spelling corrected | Toothache; rheumatism; carminative; anti-worm | Leaves, root, stem bark | Fresh organ | NR | Hormozgan herbarium | Table 1, row 140 |
| Strict toothache/oral-analgesic | S15 | Hosseini et al., Minab-Rudan | Hormozgan, Minab and Rudan | Ferula assa-foetida L. | Ferula assa-foetida L. | Unchanged | Emmenagogue (5); bites (8); toothache (9); increasing sexual desire (2) | Gum | Poultice; nut | Use count: 9; Use reports for toothache: 9 | UJH herbarium series (study-level voucher system) | Table 3, lines corresponding to Ferula assa-foetida |
| Strict toothache/oral-analgesic | S13 | Razmjoue et al., Behbahan | Khuzestan, Behbahan | Solanum nigrum L. | Solanum nigrum L. | Unchanged | For toothache; tooth disinfectant | Whole plant | Decoction (oral) | NR | 1460 | Table 3, Solanum nigrum row |
| Strict toothache/oral- | S14 | Khodayari et al., NE | Khuzestan, Northeastern | Dianthus crinitus Sm. | Dianthus crinitus Sm. | Unchanged | Relief of tooth and ear pain | Flower | NR | NR | Lorestan University herbariu | Primary plant-use table, Dianthus |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| analgesic | | Khuzestan | Khuzestan | | | | | | | | m (study-level) | crinitus row |
| Strict toothache/oral-analgesic | S14 | Khodayari et al., NE Khuzestan | Khuzestan, Northeastern Khuzestan | Teucrium polium L. | Teucrium polium L. | Unchanged | Toothache (دندان درد), among other traditional uses | Aerial parts | NR | NR | Lorestan University herbarium (study-level) | Primary plant-use table, Teucrium polium row |
| Strict toothache/oral-analgesic | S14 | Khodayari et al., NE Khuzestan | Khuzestan, Northeastern Khuzestan | Fritillaria imperialis L. | Fritillaria imperialis L. | Unchanged | Toothache, among other traditional uses | Fruit; bulb | NR | NR | Lorestan University herbarium (study-level) | Primary plant-use table, Fritillaria imperialis row |
| Strict toothache/oral-analgesic | S14 | Khodayari et al., NE Khuzestan | Khuzestan, Northeastern Khuzestan | Lycopersicum esculentum Mill. | Solanum lycopersicum L. | Synonymized | Decoction of leaf and stem for treatment of toothache | Leaf and stem for toothache; table part-use field also lists fruit, seed and flower | Decoction of leaf and stem | NR | Lorestan University herbarium (study-level) | Primary plant-use table, Lycopersicum esculentum row |
| Strict toothac | S14 | Khodayari et | Khuzestan, | Solanum | Solanum | Unchanged | Relief of toothache, | Aerial parts; fruit | NR | NR | Lorestan University | Primary plant-use |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| he/oral-analgesic | | al., NE Khuzestan | Northeastern Khuzestan | nigrum L. | nigrum L. | | among other traditional uses | | | | herbarium (study-level) | table, Solanum nigrum row |
| Strict toothache/oral-analgesic | S23 | Baroonian & Khodayari, Susan | Khuzestan, Susan district, northwest Izeh | Solanum nigrum L. | Solanum nigrum L. | Unchanged | Treatment of constipation; relief of toothache | Aerial parts | NR | NR | NR | Primary plant-use table, Solanum nigrum row |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Darab | Pistacia khinjuk Stocks | Pistacia khinjuk Stocks | Unchanged | Analgesic – oral diseases | Stem | Gum; q.d. | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1514 | Table 1, analgesic row 1 |
| Strict toothache/oral- | S25 | Zia-Behbahani et al., Fars oral | Fars, Darab; Sepidan; Farashband | Pistacia atlantica Desf. | Pistacia atlantica Desf. | Unchanged | Analgesic – oral diseases | Oleogum resin; fruit/latex; fruit/stem/leaf/latex | Gum; chewing gum; decoction | Use count: 3; No. of interviewees reportin | 1515; 1566; 1610 | Table 1, analgesic entries |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| analgesic | | diseases | | | | | | | | g oral analgesic effect: 3 | | |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Sepidan | Coriandrum sativum L. | Coriandrum sativum L. | Unchanged | Analgesic – oral diseases | Fruit; aerial part; stem; leaf | Decoction; infusion | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1066 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Kazerun | Ducrosia anethifolia (DC.) Boiss. | Ducrosia anethifolia (DC.) Boiss. | Unchanged | Analgesic – oral diseases | Fruit; aerial part; stem; leaf; flower | Infusion | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1022 | Table 1, analgesic section |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Khonj | Calotropis procera (Aiton) Dryand. | Calotropis procera (Aiton) W.T.Aiton | Spelling corrected | Analgesic – oral diseases | Latex | Crude | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1438 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Sepidan | Anthemis pseudocotula Boiss. | Anthemis pseudocotula Boiss. | Unchanged | Analgesic – oral diseases | Aerial part; leaf; flower | Decoction; infusion | Use count: 2; No. of interviewees reporting oral analgesic effect: 2 | 610 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral | Fars, Shiraz | Matricaria chamomilla L. | Matricaria chamomilla L. | Unchanged | Analgesic – oral diseases | Leaf; flower | Decoction; infusion | Use count: 1; No. of interviewees reportin | 1659 | Table 1, analgesic section |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | diseases | | | | | | | | g oral analgesic effect: 1 | | |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Farashband | Otostegia persica (Burm.f.) Boiss. | Rydingia persica (Burm.f.) Scheen & V.A.Albert | Synonymized | Analgesic – oral diseases | Flower | Decoction | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1428 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Firuzabad | Micromeria persica Boiss. | Micromeria persica Boiss. | Unchanged | Analgesic – oral diseases | Stem; leaf | Infusion | Use count: 2; No. of interviewees reporting oral analgesic effect: 2 | 1465 | Table 1, analgesic section |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Eqlid | Malva neglecta Wallr. | Malva neglecta Wallr. | Unchanged | Analgesic – oral diseases | Fruit; aerial part | Infusion; crude | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1877 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Estahban | Prosopis farcta (Banks & Sol.) J.F.Macbr. | Prosopis farcta (Banks & Sol.) J.F.Macbr. | Unchanged | Analgesic – oral diseases | Root; fruit | Crude; maceration | Use count: 1; No. of interviewees reporting oral analgesic effect: 1 | 1618 | Table 1, analgesic section |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral | Fars, Abadeh; Kazerun; Eqlid | Solanum nigrum L. | Solanum nigrum L. | Unchanged | Analgesic – oral diseases | Fruit; latex | Decoction; medicinal smoke; crude | Use count: 3; No. of interviewees reportin | 1894; 1895; 1788 | Table 1, analgesic entries |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | diseases | | | | | | | | g oral analgesic effect: 3 | | |
| Strict toothache/oral-analgesic | S25 | Zia-Behbahani et al., Fars oral diseases | Fars, Multiple Fars counties | Peganum harmala L. | Peganum harmala L. | Genus/family reassigned | Analgesic – oral diseases | Fruit; root; flower; leaf; aerial parts | Crude; decoction; inhaled; mouthwash; maceration | Use count: 6; No. of interviewees reporting oral analgesic effect: 6 | 1403; 1622; 1559; 1350 | Table 1; Results/ Discussion analgesic section |
| Broad dental/ oral | S02 | Safa et al., Hormozgan | Hormozgan | Lallemantia royleana Benth. | Dracocephalum royleanum Benth. | Synonymized | Gum bleeding | Seed | Powder | NR | NR | Table 1 |
| Broad dental/ oral | S02 | Safa et al., Hormozgan | Hormozgan | Salvadora persica L. | Salvadora persica L. | Unchanged | Cleaning teeth; strengthening gum | Leaves, root | Toothpick | NR | NR | Table 1 row 115 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broad dental/ oral | S02 | Safa et al., Hormozgan | Hormozgan | Ziziphus nummularia (Burm.f.) Wight & Arn. | Ziziphus nummularia (Burm.f.) Wight & Arn. | Unchanged | Bleeding gums | Leaves, fruit | Decoction; fresh organ | NR | NR | Table 1 row 148 |
| Broad dental/ oral | S03 | Jafarirad & Damanafshan, Darab | Fars | Rosa damascena Mill. | Rosa × damascena Herrm. | Synonymized | Gums tonic | NR | NR | FL: 50% | NR | Table 6 |
| Broad dental/ oral | S03 | Jafarirad & Damanafshan, Darab | Fars | Cassia fistula L. | Cassia fistula L. | Unchanged | Oral thrush | NR | NR | FL: 66.66% | NR | Table 6 |
| Broad dental/ oral | S05 | Dolatkhahi et al., Arjan-Parishan | Fars | Ammi majus L. | Ammi majus L. | Unchanged | As toothpick | Aerial parts | Edible / toothpick use | NR | NR | Table 1 / Mouth and Tooth category |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broad dental/ oral | S05 | Dolatkhahi et al., Arjan-Parishan | Fars | Matricaria recutita L. | Matricaria chamomilla L. | Synonymized | Listed in 'Mouth and Tooth' category | Not isolated from category table | NR | NR | NR | Table 2 |
| Broad dental/ oral | S05 | Dolatkhahi et al., Arjan-Parishan | Fars | Ephedra pachyclada Boiss. | Ephedra pachyclada Boiss. | Unchanged | Mouthwash | Stem, leaves | Decoction | NR | NR | Table 1 + Table 2 (Mouth and Tooth category) |
| Broad dental/ oral | S05 | Dolatkhahi et al., Arjan-Parishan | Fars | Juglans regia L. | Juglans regia L. | Unchanged | Listed in 'Mouth and Tooth' category | NR | NR | NR | NR | Table 2 |
| Broad dental/ oral | S05 | Dolatkhahi et al., Arjan-Parishan | Fars | Ocimum basilicum L. | Ocimum basilicum L. | Unchanged | Mouth wound | Leaves | Edible | NR | NR | Table 1 / Table 2 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Broad dental/ oral | S03 | Jafarirad & Damanafshan, Darab | Fars | Vitex agnus castus | Vitex agnus-castus L. | Synonymized | Elimination of dental larva | Seed | Burning | Reported by: 12 persons | NR | Table 2, p.109 (PDF page 8) |
| Broad dental/ oral | S08 | Moein et al., Darab | Fars | Bassia eriophora (Schrad.) Asch. | Bassia eriophora (Schrad.) Asch. | Unchanged | Gingivitis | Leaf, twig | Infusion | NR | NR | Table 1, p.41 (PDF page 2) |
| Broad dental/ oral | S15 | Hosseini et al., Minab-Rudan | Hormozgan | Pistacia khinjuk Stocks | Pistacia khinjuk Stocks | Unchanged | Gingival tonic (3) | Leaf, root, seed | Decoction; nut | Use reports: 3 | NR | Table 3 |
| Broad dental/ oral | S15 | Hosseini et al., Minab-Rudan | Hormozgan | Ephedra pachycl ada Boiss. | Ephedra pachycl ada Boiss. | Unchanged | Mouth diseases (5) | Stem, leaf | Powder; poultice | Use reports: 5 | NR | Table 3 |
| Broad dental/ oral | S15 | Hosseini et al., | Hormozgan | Salvadora | Salvadora | Unchanged | Gum tonic (13) | Stem skin, leaf | Poultice; chewing gum | Use reports: 13 | NR | Table 3 |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Minab-Rudan | | persica L. | persica L. | | | | | | | |
| Broad dental/ oral | S11 | Khazaei et al., North/ West Dashtestan | Bushehr | Zataria multiflora Boiss. | Zataria multiflora Boiss. | Unchanged | Mouth and dental infections | Leaves and flowers | NR | NR | NR | Discussion, p.381; lines 657-664 in searchable full text |
| Broad dental/ oral | S11 | Khazaei et al., North/ West Dashtestan | Bushehr | Plantago psyllium L. | Plantago arenaria Waldst. & Kit. | Synonymized | Gum infection | Seed | NR | NR | NR | Discussion, p.387; lines 1005-1017 in searchable full text |
| Broad dental/ oral | S19 | Abolzadeh et al., Tangestan | Bushehr | Plantago psyllium L. | Plantago arenaria Waldst. & Kit. | Synonymized | Dental infection | NR | NR | NR | NR | Discussion, PDF p.10; searchable lines 611-633 |
| Broad dental/ oral | S13 | Razmjoue et al., | Khuzestan | Anthriscus nemoro | Anthriscus nemoro | Synonymized | Mouth freshener/ deodorizer | Whole plant (table); | Raw / used as a spice with food (oral) | NR | NR | Table 3, Anthriscus |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Behbahan | | sa (M.Bieb.) Spreng. | sus (M.Bieb.) Spreng. | | | leaf and stem mentioned in use description | | | | nemorosa row |
| Broad dental/ oral | S13 | Razmjoue et al., Behbahan | Khuzestan | Anthemis cotula L. | Anthemis cotula L. | Unchanged | Gargling to relieve inflammation of gums, throat and mouth | Whole plant | Infusion; gargle described in medicinal-use text | NR | NR | Table 3, Anthemis cotula row |
| Broad dental/ oral | S13 | Razmjoue et al., Behbahan | Khuzestan | Astragalus gossypinus Fischer | Astragalus gossypinus Fisch. | Spelling corrected | Anti-inflammatory for gums; helps open purulent boils | Root | Decoction (oral) | NR | NR | Table 3, Astragalus gossypinus row |
| Broad dental/ oral | S06 | Ghafouri et al., Southern Fars (comp | Fars | Astragalus fasciculifolius Boiss. | Astragalus fasciculifolius Boiss. | Unchanged | Stem used as a toothbrush | Stem | Direct use as toothbrush | NR | NR | Companion preprint, Results / diverse |

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| Evidence layer | Study ID | Study/ source | Province /locality | Taxon as reported | Harmonized taxon | Taxonomic action | Reported indication | Plant part | Preparation/administration | Frequency/index | Voucher/ herbarium | Exact source location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | anion source | | | | | | | | | | plant uses, p.6 |

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**Taxonomic-action coding:** Unchanged = no substantive nomenclatural change; Synonymized = source-reported name reconciled to an accepted/harmonized synonym; Spelling corrected = orthographic/author-citation correction without a substantive taxon change; Genus/family reassigned = historical family or higher-level placement corrected; Unresolved = source evidence did not justify further taxonomic resolution.

**Traceability note:** Source locations reproduce the retained extraction record. Where plant part, preparation/administration, frequency/index, or voucher information was not available at row level, NR is reported rather than inferred.

Taken together, the synthesis showed a literature characterized less by a single universally shared list of remedies than by high local diversity with a small recurrent core. Recurrence was meaningful when present, but regional variation in indication and preparation was equally prominent. The broad oral-care layer further showed that dental pain remedies were embedded within a wider local system of gingival care, infection management, oral hygiene, and mouth-related practices.

The results therefore support a layered interpretation: taxonomic recurrence can identify candidates for further investigation, whereas geographic variation in reported indications and preparation differences preserve the local ethnobotanical context that would be lost in a simple species-frequency ranking.

## Discussion

The main pattern was high taxonomic diversity with limited cross-study replication, indicating that richness and regional consistency are distinct properties of the evidence. Broader Iranian and international reviews likewise document numerous plants associated with toothache [1,2,12,13], but aggregation across regions can obscure how strongly individual records depend on local surveys. The present source-level synthesis therefore positions most reported taxa as locally documented ethnobotanical signals rather than components of a uniformly shared Southern-Iran repertoire.

The recurrent taxa warrant further investigation, but recurrence alone does not establish pharmacological priority. Stronger prioritization should also consider consistency of indication, taxonomic certainty, preparation similarity, and independent supporting evidence. Likewise, the prominence of Asteraceae, Lamiaceae, Apiaceae, and Solanaceae should be interpreted as ethnobotanical representation rather than therapeutic superiority [3]. Recurrence also does not establish efficacy or oral safety, particularly where dose, preparation, or potentially toxic constituents remain insufficiently characterized.

The comparator evidence added an important second dimension. Studies from Kerman, Kohgiluyeh and Boyer-Ahmad, and Ilam contained taxa that either converged with Southern-Iran toothache records or occupied a different position within the oral-care repertoire [30–35]. For example, *Peganum harmala* showed pain-related recurrence across several regional datasets, whereas taxa such as Pistacia khinjuk and Teucrium polium were reported for different oral indications across regions, including gingival care, mouth freshening, and other oral uses. The primary Kohgiluyeh and Boyer-Ahmad table also confirmed several direct toothache records that had to be distinguished from associations transmitted through later reviews [31]. These observations support the usefulness of treating ethnobotanical evidence as a taxon–indication–geography relationship, rather than reducing it to a binary statement that a particular species is or is not a "toothache plant."

Within Southern Iran, Bushehr yielded no source-confirmed strict toothache record, but broad gum and dental-infection uses were documented [27,28]; therefore, the absence of strict records should not be interpreted as absence of local practice. Fars, Hormozgan, and Khuzestan likewise showed different combinations of toothache, gingival, oral-hygiene, and other oral uses [4–

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11,24–29], supporting interpretation of toothache remedies within a wider oral-care system.

Preparation also varied across studies. Decoctions were common, but direct placement, crude or fresh material, chewing, gum/resin application, fumigation, and smoke were reported, including heterogeneous practices in Darab and Akbarabad/Kavar [24–26]. Geographic variation in reported indications may reflect differences in local availability, knowledge transmission, informant composition, survey design, taxonomic resolution, or reporting, but the available studies do not permit these explanations to be separated causally [32–35].

Source-level verification and taxonomic harmonization improved interpretability by distinguishing toothache from broader oral uses and preventing synonymous names from being counted as separate taxa. These procedures are consistent with ethnopharmacological reporting principles requiring traceable plant–use relationships [14]. Retaining both source-reported and harmonized names also avoided implying retrospective re-identification of unavailable specimens.

AI-assisted processing was limited to flagging candidate spelling, synonym, and cross-document correspondences for manual verification against primary sources and botanical authorities. This supporting role is consistent with recent AI-assisted evidence-synthesis approaches [22,23]; no AI output was treated as independent evidence.

The project-specific appraisal indicated generally adequate reporting but was not a validated risk-of-bias instrument. Heterogeneity in sampling, denominators, terminology, and calculation of UV, RFC, FL, and ICF precluded meaningful pooling; cross-study replication was therefore used descriptively.

Several limitations should be acknowledged. Screening and extraction were conducted by one reviewer; database coverage was incomplete; grey literature and languages beyond the documented English/Persian searching were not systematically searched; and historical search yields and complete AI-interaction metadata were not retained. The review is therefore susceptible to publication, retrieval, language, and selection biases, including comparator selection from relevant retrievable studies rather than a prespecified national sample. Geographic coverage was uneven, some source tables were inaccessible, and the project-specific reporting appraisal was not a validated risk-of-bias tool. Finally, nomenclatural harmonization cannot re-identify historical specimens, and published traditional-use evidence cannot establish efficacy, dose, causality, or oral safety.

These limitations also indicate the most useful direction for future research. Plants should not be prioritized simply because they appear in a long national list. A stronger strategy would combine independent recurrence, consistency of indication, source-level traceability, preparation similarity, taxonomic certainty, and independent supporting evidence. On that basis, the recurrent Southern taxa and selected cross-regional taxa constitute reasonable candidates for targeted phytochemical, pharmacological, antimicrobial, anti-inflammatory, analgesic, safety, and eventually clinically relevant oral-health studies. Future fieldwork would also benefit from standardized voucher documentation and indication-specific reporting so that the distinction between toothache, dental infection, gingival disease, and general oral care is preserved from the outset.

## Conclusion

This review shows high taxonomic and family diversity but limited cross-study replication in Southern-Iran ethnobotanical evidence on toothache and oral pain. The recurrent taxa—Solanum nigrum, Zataria multiflora, and Matricaria chamomilla—represent ethnobotanical signals for further study, not evidence of clinical efficacy or oral safety, particularly where dose and preparation remain uncertain. Source verification and taxonomic harmonization improved

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traceability, while AI was used only as a manually verified support tool.

## Ethical Approval

This study was based exclusively on previously published literature and did not involve new human participants, identifiable personal data, animals, or new plant collection. Accordingly, any requirement for ethics review was subject to the applicable institutional and jurisdictional policies for secondary research.

## Consent to Participate

Not applicable.

## Data Availability

All evidence supporting the synthesis is derived from the cited published sources. Extracted evidence, taxonomic actions, source traceability, quality appraisal, and supporting methodological data are provided in Supplementary Tables S1–S5.

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## Conflict of Interest

The author declares no conflict of interest related to this study or its publication.

## Authors' Contributions

The author was responsible for the conceptualization and design of the study, literature search and source verification, data extraction and analysis, taxonomic and thematic synthesis, interpretation of the findings, preparation of the manuscript, critical revision, and approval of the final version for publication.

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