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Original Article

Preserving Traditional Knowledge: Cultural Erosion of Plants Used Against Parasitosis

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ABSTRACT

Background: Medicinal plants are a primary healthcare resource in rural and suburban communities, particularly for infectious diseases such as intestinal parasitosis. However, traditional knowledge is increasingly threatened by urbanization and limited intergenerational transmission. This study aimed to document and analyze the ethnopharmacological knowledge of medicinal plants used for parasitosis in five suburban communities of Campeche, Mexico, and to assess its conservation status. **Methods:** A cross-sectional descriptive study was conducted using 247 semi-structured interviews in Castamay, Nohakal, Tikinmul, Kobén, and Imí. Data on plant knowledge, use, preparation, cultivation, and transmission were collected and analyzed using descriptive statistics and ethnobotanical indices, including relative frequency of mention (RFM), relative frequency of citation (RFC), and community knowledge index (CI). **Results:** A total of 76% of respondents reported knowledge of at least one antiparasitic medicinal plant. The most cited species were *Dysphania ambrosioides*, *Cocos nucifera*, *Origanum vulgare*, *Artemisia vulgaris*, and *Ricinus communis*. Most plants were also used as food or condiments, although *D. ambrosioides* was specifically recognized for its antiparasitic properties. Higher CI values were observed in Castamay (4.29), Tikinmul (3.87), and Nohakal (3.80), whereas lower values were found in Kobén (2.89) and Imí (3.30). Knowledge transmission and cultivation practices were limited across communities. **Conclusions:** Suburban communities in Campeche retain relevant ethnopharmacological knowledge; however, lower knowledge indices in more urbanized communities suggest ongoing cultural erosion. These findings highlight the need to strengthen documentation, intergenerational transmission, and sustainable management of medicinal plants to support both biodiversity conservation and culturally appropriate public health strategies.

Keywords: Ethnopharmacology; Traditional Knowledge; Antiparasitic Plants; Cultural Erosion; Campeche; Medicinal Plants

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INTRODUCTION

Medicinal plants represent a primary healthcare resource for more than 80% of the world's population, particularly in developing countries where plant diversity provides a wide range of bioactive secondary metabolites[1,2]. Low-income populations frequently rely on these resources due to their affordability and accessibility compared to conventional therapies[1-3]. The preservation and transmission of traditional knowledge are essential for maintaining cultural identity and healthcare practices in rural and suburban communities, which has motivated numerous ethnopharmacological studies worldwide[1,3,4].

Parasitic diseases impose a significant public health burden in rural and suburban settings, especially in contexts characterized by malnutrition, poverty, and limited access to healthcare services[5-7]. In such environments, medicinal plants represent an accessible and culturally accepted alternative for managing intestinal parasites, potentially reducing the indiscriminate use of synthetic antiparasitic drugs and their associated environmental and health risks[4-6]. In this regard, the World Health Organization has recognized traditional medicine as a key component of primary healthcare systems[7].

Despite their relevance, both medicinal plant resources and the associated traditional knowledge are increasingly threatened by biodiversity loss and sociocultural changes[1,2,9]. In suburban communities, medicinal plants continue to play a crucial role; however, the erosion of ethnopharmacological knowledge has been documented in various contexts and is closely linked to environmental degradation and reduced ecosystem sustainability[9-12]. Cultural factors also influence the perception, valuation, and safe use of these natural resources[10-12].

In Mexico, ethnobotanical research has documented a high diversity of medicinal plant use across regions; however, most studies have focused on rural or highly indigenous communities, with comparatively less attention given to suburban populations undergoing rapid socio-environmental transitions[13-16]. These contexts are particularly relevant, as they reflect dynamic interactions between traditional knowledge systems and modernization processes, which may lead to the selective retention, transformation, or loss of ethnopharmacological practices[13,14].

The State of Campeche, located in southeastern Mexico, comprises small suburban communities with significant indigenous heritage, socioeconomic vulnerability, and limited access to formal healthcare services. These conditions make the region particularly suitable for evaluating the conservation and transformation of traditional medicinal knowledge.

In this context, the present study addresses a gap in ethnobotanical research in Mexico by focusing

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on suburban communities and by applying an integrated quantitative approach combining Relative Frequency of Mention (RFM), Relative Frequency of Citation (RFC), and Community Knowledge Index (CI). This integrated approach allows a multidimensional assessment of cultural relevance, consensus, and knowledge conservation across the study communities.

This study focuses on five communities in the Municipality of Campeche: Castamay, Nohakal, Tikinmul, Kobén, and Imí. The objective was to document and analyze traditional knowledge of antiparasitic medicinal plants, quantify its conservation using ethnobotanical indices, and provide a robust baseline for future pharmacological validation and conservation strategies.

METHODS

This study was conducted in five suburban communities within the Municipality of Campeche, southeastern Mexico: Castamay, Nohakal, Tikinmul, Kobén, and Imí. The selection of these communities was based on predefined sociodemographic criteria, including a population size of fewer than 3,000 inhabitants, literacy rates below 90%, and an average schooling level of approximately seven years. Additionally, all communities presented an indigenous population exceeding 5%, predominantly composed of Mayan speakers, as well as high coverage of basic household services such as piped water, electricity, sanitation facilities, and refrigeration. Variation in geographic and infrastructural connectivity with the state capital, San Francisco de Campeche, was also considered, allowing for a comparative assessment of the influence of urbanization on the preservation and transmission of traditional ethnopharmacological knowledge.

An observational, descriptive, cross-sectional ethnopharmacological study design was employed. Prior to data collection, the objectives and scope of the research were formally presented to local authorities, and authorization was obtained. Preliminary field visits were conducted to establish rapport with community members and to gain a contextual understanding of local social dynamics and cultural practices. All participants were informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality and anonymity of the data collected. Written informed consent was obtained from all participants prior to inclusion in the study. The research adhered to internationally recognized bioethical principles, including autonomy, beneficence, non-maleficence, and justice. Confidential handling of information was ensured at all stages, and no physical, psychological, or environmental harm resulted from the study. As part of an ethical commitment to reciprocity, study findings will be communicated to the participating communities.

Ethnopharmacological data were obtained through 247 semi-structured interviews conducted between 2023 and 2024. The distribution of interviews across the study sites was as follows: Castamay (n = 46), Nohakal (n = 48), Tikinmul (n = 53), Kobén (n = 52), and Imí (n = 48). Sample size in each community was determined through voluntary participation and continued until theoretical saturation was achieved, ensuring that no substantially new information emerged. The semi-structured interview guide was designed to capture detailed information on the knowledge and use of medicinal plants with antiparasitic properties. Participants were asked about local plant names, species identification, preparation methods (including infusions, decoctions, and direct consumption), routes of administration, dosage practices, cultivation and collection methods, and mechanisms of knowledge transmission. Additional questions explored whether participants recommended these plants to others and the sources from which they obtained them. Whenever possible, plant specimens mentioned during interviews were collected in situ to support taxonomic identification and to facilitate future phytochemical and pharmacological analyses.

Collected plant specimens were processed under laboratory conditions and preliminarily identified using specialized botanical literature and comparison with authenticated reference materials. Scientific nomenclature was verified using the Plants of the World Online database (Royal Botanic Gardens, Kew), ensuring taxonomic accuracy and consistency. Voucher specimens were prepared and deposited at the Faculty of Chemical-Biological Sciences, Autonomous University of Campeche, and are available upon request.

All interview data were compiled and organized using Microsoft Excel. Descriptive statistical analyses were conducted to summarize the data and generate exploratory graphical representations. To quantitatively evaluate ethnobotanical knowledge, three complementary indices were calculated. The Relative Frequency of Mention (RFM) was used to estimate the proportion of participants who mentioned each plant species relative to the total number of respondents, reflecting its overall prominence within the study population. The Relative Frequency of Citation (RFC) was calculated as the number of participants who cited each species divided by the total number of participants who reported knowledge of at least one antiparasitic plant, providing a refined measure of the relative importance of each species among knowledgeable informants.

In addition, the Community Knowledge Index (CI) was determined as the average number of antiparasitic plant species known per knowledgeable informant within each community, allowing for comparative analysis of knowledge richness across localities. The combined application of RFM, RFC, and CI enables a multidimensional assessment of ethnopharmacological knowledge by integrating species prominence, informant consensus, and community-level knowledge depth. Given the descriptive and exploratory nature of the study, the analysis focused on descriptive statistics and ethnobotanical indices. Additionally, the distribution of the number of plant species mentioned per participant was analyzed to explore intra-community variability and to identify patterns associated with knowledge retention and potential erosion.

RESULTS

A total of 247 interviews were conducted across the five suburban communities, distributed as follows: Castamay (n = 46), Nohakal (n = 48), Tikinmul (n = 53), Kobén (n = 52), and Imí (n = 48). The demographic profile of participants was consistent with the general characteristics of these communities, including a predominance of individuals of Mayan descent, an average of seven years of schooling, and more than 85% of households having access to basic services such as piped water, electricity, sanitation facilities, and refrigeration (Figure 1).

Regarding ethnopharmacological knowledge, 188 respondents (76.1%) reported familiarity with at least one medicinal plant used for the treatment of parasitosis. Participants demonstrated varying levels of knowledge, ranging from simple recognition of plant species to detailed understanding of preparation methods and administration. Practices such as identifying, preparing, and using medicinal plants were widely preserved, whereas activities related to knowledge transmission, such as teaching and recommending, were less frequent. Similarly, the cultivation of medicinal plants was limited across all communities.

Overall, knowledge-related practices such as knowing, identifying, preparing, and using medicinal plants showed values exceeding 70% across communities. In contrast, practices related to knowledge transmission, including recommending and teaching, were below 40%, while cultivation remained below 30%, indicating reliance on wild collection and potential vulnerability in knowledge sustainability.

A total of twelve plant species were reported as being used for the treatment of parasitosis. The most widely recognized and utilized

species across all communities was *Dysphania ambrosioides*, followed by *Cocos nucifera*. Other frequently cited species included *Origanum vulgare*, *Artemisia vulgaris*, and *Ricinus communis*. Notably, these five species accounted for approximately 71% of all mentions, highlighting their central role in local ethnopharmacological practices (Figure 2).

Most plants identified as having antiparasitic properties also serve as food or condiments, including tamarind (*Tamarindus indica*), pumpkin (*Cucurbita* spp.), coconut (*Cocos nucifera*), guava (*Psidium guajava*), papaya (*Carica papaya*), and lemon (*Citrus limon*), as well as garlic (*Allium sativum*), pepper (*Capsicum* spp.), oregano (*Origanum vulgare*), and epazote (*Dysphania ambrosioides*). This dual function likely contributes to their conservation and continued use within the communities.

Quantitative ethnobotanical analysis revealed differences in the prominence and perceived importance of species. The Relative Frequency of Mention (RFM) and Relative Frequency of Citation (RFC) were calculated to assess these patterns. While RFM reflects the general recognition of species across all respondents, RFC provides insight into their importance among knowledgeable informants (Figure 3).

Comparison of RFM and RFC values indicates that certain species exhibit higher cultural relevance than their overall frequency of mention would suggest. For example, *Cocos nucifera* presented relatively high RFC values despite not being the most frequently cited species, highlighting differences between general awareness and perceived importance.

At the community level, the Knowledge Index (CI) revealed variations in the depth of ethnopharmacological knowledge. The highest CI values were observed in Castamay (4.29), followed by Tikinmul (3.87) and Nohakal (3.80), whereas lower values were recorded in Imí (3.30) and Kobén (2.89), suggesting reduced knowledge richness in communities with greater urban influence (Figure 4).

The overall CI value across all communities was 3.67, indicating a moderate level of knowledge retention at the regional scale. These results suggest that while ethnopharmacological knowledge remains present, it is unevenly distributed and potentially vulnerable to erosion in more urbanized settings.

To further explore intra-community variability, the distribution of the number of medicinal plants known per respondent was analyzed. Considerable variation was observed within each community, with some individuals reporting knowledge of up to five or more species, while others mentioned only one (Figure 5).

This variability reinforces the presence of heterogeneous knowledge distribution and supports the observation that cultural erosion is occurring unevenly within and between communities. In particular, the presence of individuals with minimal knowledge alongside highly knowledgeable informants suggests a weakening of knowledge transmission processes.

Finally, it is noteworthy that only 13 respondents reported the use of medicinal plants for treating parasitic infections in animals, primarily through the administration of *Dysphania ambrosioides* to puppies. This limited practice highlights a gap in ethnopharmacological knowledge that could be relevant for integrated approaches to parasite control.

DISCUSSION

The present study demonstrates that suburban communities in the Municipality of Campeche retain substantial traditional knowledge regarding the use of medicinal plants for the treatment of parasitosis, with 76% of respondents reporting familiarity with at least one antiparasitic species. Nevertheless, the findings also reveal concerning patterns of knowledge erosion, particularly in communities with greater connectivity to urban centers. Lower Knowledge Index values in Kobén (CI = 2.89) and Imí (CI = 3.30) compared to more isolated communities

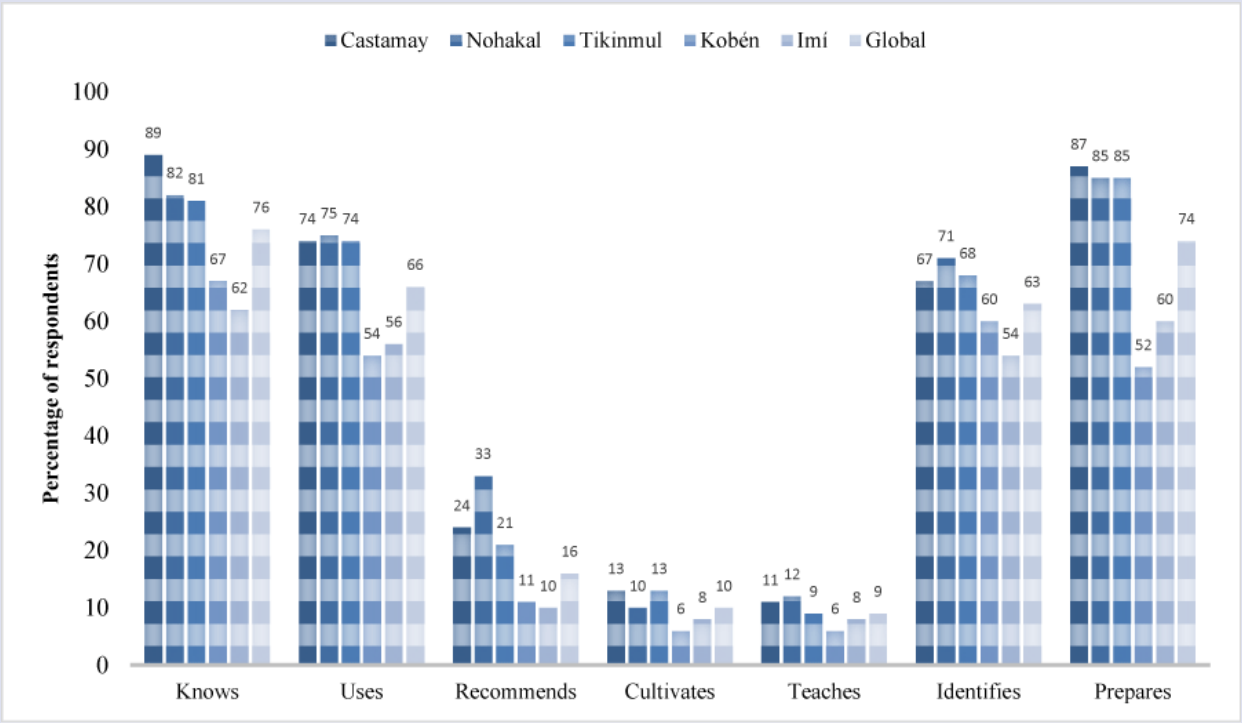

Figure 1. Practices of respondents regarding medicinal plants used to treat parasitosis in five suburban communities of Campeche, Mexico. Bars represent the percentage of participants in each community who reported knowing, identifying, preparing, using, recommending, teaching, and cultivating antiparasitic plants. The last bar in each group represents the overall mean across all communities.

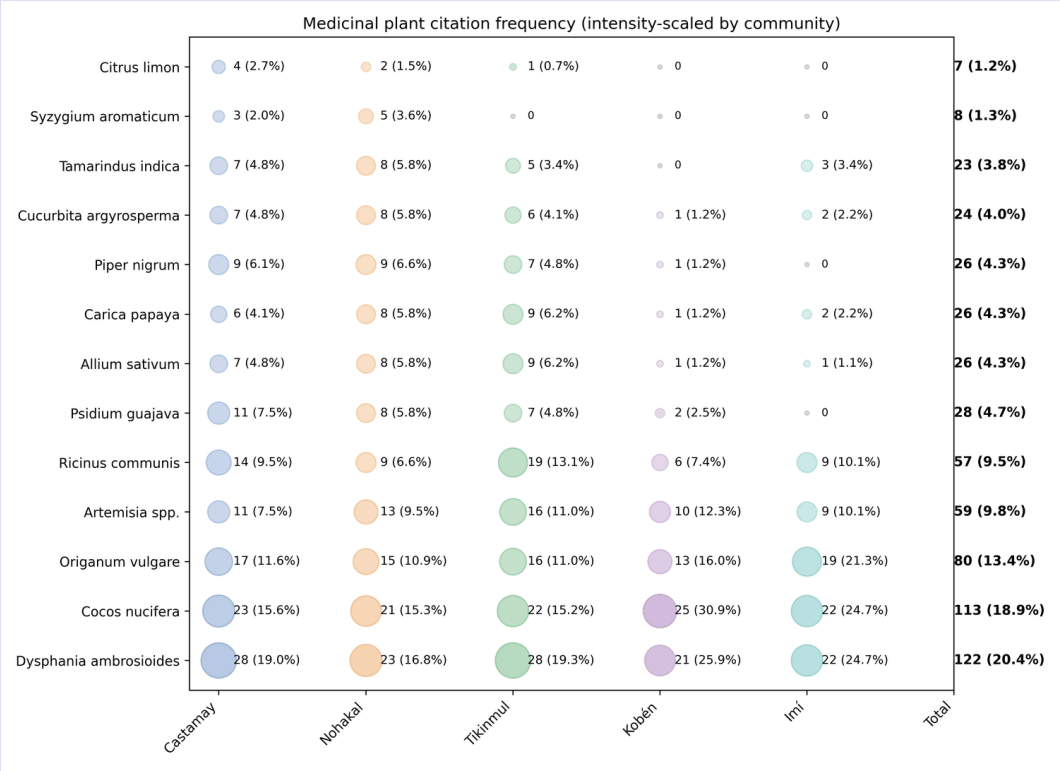

Figure 2. Bubble plot showing the distribution and citation frequency of medicinal plant species across five suburban communities in Campeche, Mexico, including an overall total column. Bubble size represents the absolute number of citations per species and locality. Color intensity corresponds to citation magnitude within each community. Values are expressed as the number of citations followed by the percentage contribution within each community and across the total dataset. Species are ordered according to total frequency, highlighting dominant and less frequently used taxa. Zeros are explicitly indicated to denote absence of reported use.

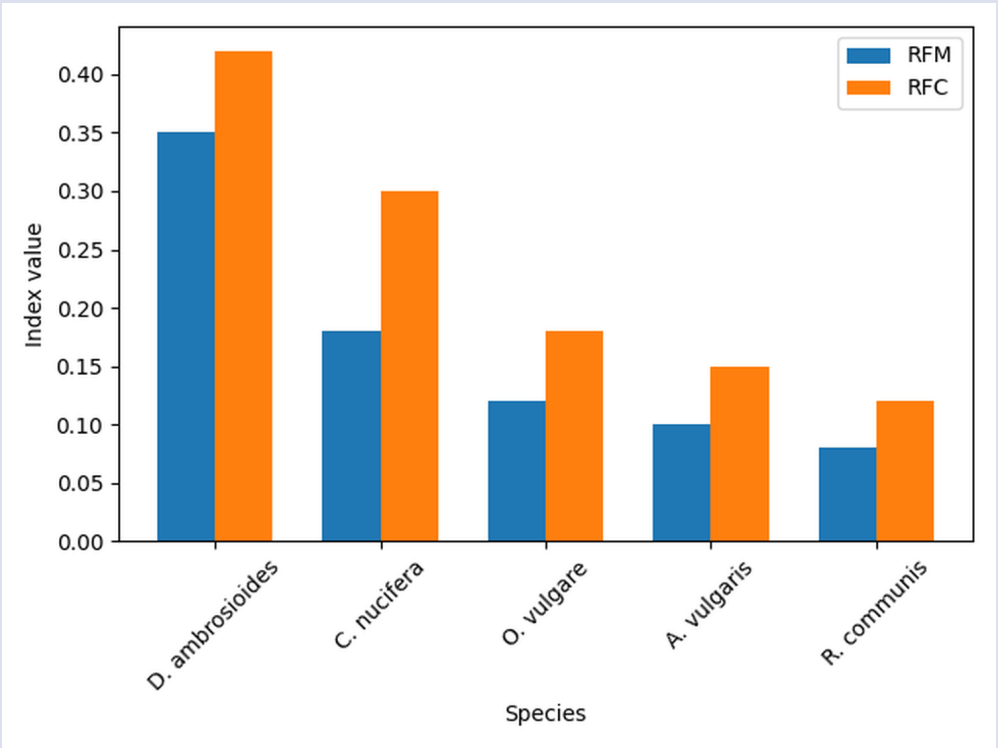

Figure 3. Comparison of Relative Frequency of Mention (RFM) and Relative Frequency of Citation (RFC) of antiparasitic medicinal plants in five suburban communities of Campeche, Mexico.

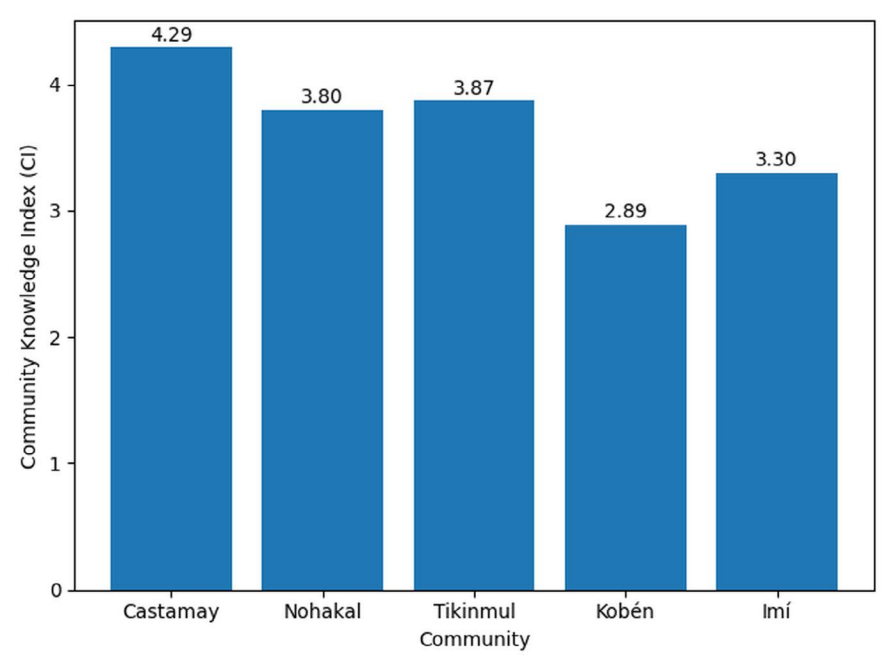

Figure 4. Community Knowledge Index (CI) of antiparasitic medicinal plants across five suburban communities of Campeche, Mexico.

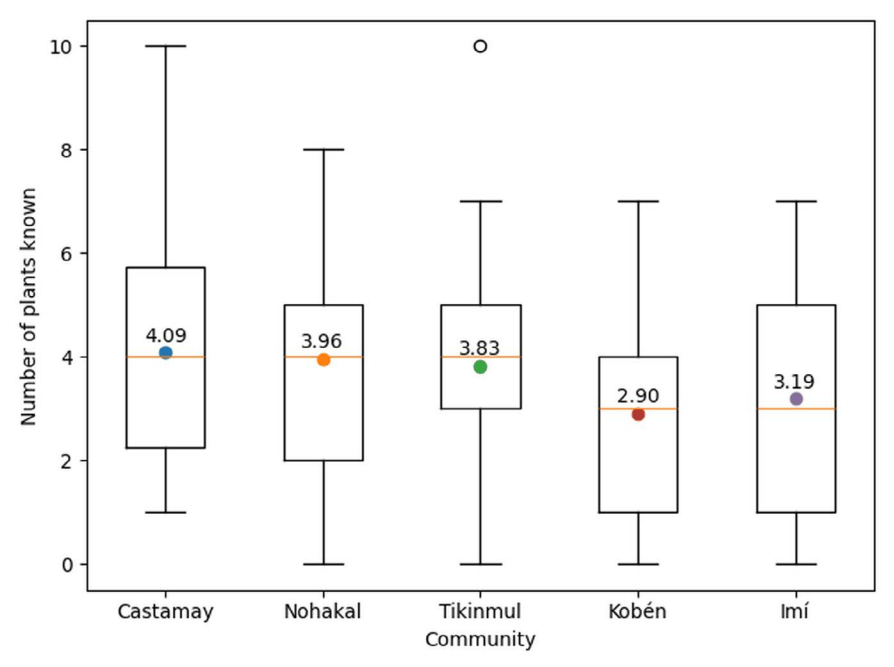

Figure 5. Distribution of the number of antiparasitic medicinal plants known per respondent across five suburban communities of Campeche, Mexico. Boxplots represent variability within each community, and points indicate mean values.

such as Castamay (CI = 4.29) suggest that proximity to the state capital is associated with accelerated loss of ethnopharmacological knowledge. These findings emphasize the importance of suburban contexts, which remain underrepresented in ethnobotanical studies in Mexico despite being critical zones of cultural transition.

This pattern is consistent with observations reported in other regions of Mexico and Latin America. Similar trends have been documented in Guerrero, Mexico, where communities located near urban areas exhibit a marked erosion of traditional plant knowledge[13]. In a comparable context, processes of modernization and acculturation in Colombia have been shown to negatively influence the transmission of ethnobotanical knowledge[14]. At a global scale, the progressive loss of traditional knowledge represents a significant concern, not only in terms of cultural heritage preservation, but also due to the consequent reduction in opportunities for the identification and development of novel therapeutic agents in biodiverse regions[1,8,9,15,16].

A key methodological contribution of this study is the combined use of ethnobotanical indices, specifically Relative Frequency of Mention (RFM), Relative Frequency of Citation (RFC), and Community Knowledge Index (CI). While previous studies often rely on a single index[8], the integrated application of these metrics enables a more comprehensive evaluation of ethnopharmacological knowledge by simultaneously capturing species recognition, cultural importance, and knowledge depth at the community level. This approach allows the identification of patterns of knowledge conservation and erosion that would not be evident if each index were used independently.

The study also revealed that practices associated with "recommend" and "teach" were markedly lower than "know," "identify," "prepare," and "use" (Figure 1). These behaviors are critical for intergenerational transmission, and their low prevalence indicates that knowledge erosion may continue if younger generations are not actively engaged. Similar patterns have been observed in quilombola communities in Brazil, where knowledge persists among elders but transmission to youth is declining[4,10-12].

Dysphania ambrosioides (epazote) was the most recognized and used species, consistent with its high frequency of mentions (Figure 2) and extensive documentation throughout Mesoamerica. López de Guimaraes et al.[5] demonstrated the efficacy of *D. ambrosioides* compared to albendazole in children, providing pharmacological validation for its traditional use. The plant's active compounds, including ascaridole and other monoterpenes, exhibit anthelmintic activity against various intestinal parasites[5,7].

Cocos nucifera (coconut) was the second most cited species, with its water consumed directly as an antiparasitic remedy. Although commonly valued for its nutritional and hydrating properties, its traditional antiparasitic use has been documented in other tropical regions[16,17]. Notably, its relatively high RFC value (Figure 3) compared to its overall frequency of mention highlights that cultural importance does not always correlate with general recognition, reinforcing the value of combining RFM and RFC for a more nuanced interpretation of ethnopharmacological relevance.

Other frequently cited species included *Origanum vulgare* (oregano), *Artemisia vulgaris* (mugwort), and *Ricinus communis* (castor bean). The antiparasitic activity of oregano is attributed to essential oil components, such as thymol and carvacrol, which have demonstrated efficacy against various pathogens[7,17]. Mugwort is traditionally used worldwide for digestive complaints and parasitic infections[15], while castor bean functions as a purgative, specifically associated by residents with "disinfecting the stomach."

Most plants reported as antiparasitic also serve as food (tamarind, pumpkin, coconut, guava, papaya, lemon) or condiments (epazote, garlic, pepper, oregano). This dual use promotes both the conservation of species and the preservation of knowledge. Domestic gardens and backyard cultivation play a crucial role in maintaining plant biodiversity and the associated ethnopharmacological knowledge[20-22,24,25]. Plants with multiple functions are more likely to be maintained and transmitted intergenerationally.

Epazote, in particular, benefits from this dual purpose, being both a culinary herb and a recognized antiparasitic agent. In contrast, species used exclusively for medicinal purposes, such as mugwort and castor bean, showed more variable recognition and may be at greater risk of knowledge loss among younger generations[13,16].

From a public health perspective, these findings underscore the continued relevance of medicinal plants as accessible and culturally accepted alternatives for the management of parasitic infections, particularly in underserved populations. The integration of traditional remedies into local health strategies could contribute to reducing the indiscriminate use of synthetic antiparasitic drugs, which has been associated with increasing drug resistance and environmental contamination[5-7,17,18].

Most parasitic infections are zoonotic, indicating that domestic and free-roaming animals should also be dewormed to prevent reinfections[7,17,18]. Only 13 respondents across all communities mentioned this practice, reporting that puppies were sometimes given epazote (*Dysphania ambrosioides*), particularly when showing signs of abdominal distension. This observation highlights an opportunity to expand ethnopharmacological knowledge within a One Health framework, integrating human, animal, and environmental health approaches.

Knowledge erosion also affects biodiversity conservation. Communities with stronger traditional knowledge are more likely to engage in practices that protect medicinal plants and their habitats[12,19,20]. Cultivation of medicinal plants in domestic gardens, which was reported at low levels across communities (Figure 1), is a critical intervention point for conservation. Small-scale cultivation ensures access to quality plant material and supports agroecological practices that enhance secondary metabolite production, which is essential for pharmacological efficacy[21-25].

Future pharmacognostic studies planned for the most cited species, particularly *Dysphania ambrosioides* and *Cocos nucifera*, will consider cultivation practices, plant age, and environmental factors to evaluate bioactive compound profiles and antiparasitic activity effectively[23].

Several limitations should be acknowledged. First, the ethnopharmacological information is based on self-reports and has not been validated through pharmacological assays. Second, although taxonomic identification was performed in-house, it has not been confirmed by external botanical experts or deposited in an officially recognized herbarium. Third, the cross-sectional design captures current knowledge but does not allow direct assessment of temporal trends. Finally, while the sample size was adequate for descriptive analysis, it may not represent all variations within the communities. Future studies should incorporate pharmacological validation, expert taxonomic confirmation, longitudinal designs, and expanded sampling to address these limitations.

CONCLUSION

Traditional knowledge of medicinal plants used against intestinal parasitosis remains prevalent among suburban communities in Campeche, Mexico, with 76% of respondents reporting familiarity with at least one antiparasitic species. However, this knowledge is unevenly distributed, as reflected by Community Knowledge Index (CI) values ranging from 2.89 in Kobén to 4.29 in Castamay. Communities with greater connectivity to urban centers exhibited lower CI values, suggesting an association between urban influence and the erosion of ethnopharmacological knowledge. *Dysphania ambrosioides* (epazote) was the most frequently cited species, followed by *Cocos nucifera*, *Origanum vulgare*, *Artemisia vulgaris*, and *Ricinus communis*, most of which serve dual purposes as food or condiments—a factor that may contribute to their continued use.

The integrated application of Relative Frequency of Mention (RFM), Relative Frequency of Citation (RFC), and Community Knowledge Index (CI) provided a multidimensional assessment of knowledge distribution and cultural relevance across a gradient of urban influence. These findings underscore the urgent need for documentation strategies, intergenerational transmission, and sustainable cultivation practices to prevent further cultural erosion. Furthermore, the documented uses of antiparasitic plants, particularly *D. ambrosioides*, offer a robust foundation for future pharmacognostic and pharmacological studies aimed at validating their bioactive properties and supporting evidence-based integration into public health strategies.

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