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Original Article

A Survey-Based Cross-Sectional Study of Traditional Knowledge and Contemporary Use of Macedonian Wild Thyme Within Integrative Medicine

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ABSTRACT

Background: Thymus serpyllum (wild thyme) is an important ethnobotanical species in North Macedonia, where it is widely used in traditional medicine.
Methods: This descriptive cross-sectional survey study explored patterns of thyme usage, knowledge sources, and collection practices amongst 182 participants from all eight regions of the country. Statistical analyses included the χ^2 test, Kruskal–Wallis, and exploratory cluster analysis.
Results: Most of the participants reported using thyme as a tea (89.6%) to treat respiratory conditions (57.7%), followed by stress-related complaints (24.7%), and preventive purposes (22.0%). Family traditions were the main source of knowledge (37.4%), whilst internet resources and combined sources were more common amongst younger and highly educated participants. Nearly half of the participants (47.8%) reported collecting thyme themselves mainly from mountainous areas, with regional differences in collection behavior ($p < 0.05$). Statistical analyses showed a heterogeneous user of wild thyme profile which ranged from traditional self-collectors relying on intergenerational knowledge to urban consumers influenced by digital information and acquisition through markets. Qualitative responses confirmed the persistence of word of mouth and various therapeutic applications, especially for respiratory and gastrointestinal complaints.
Conclusion: Whilst the use of thyme remains culturally ingrained and widely accepted as a complementary remedy, reliance on wild harvesting raises sustainability concerns and clinical validation for several indications remains limited. These results show the continuing relevance of wild thyme in contemporary ethnomedicine and point to the need for integrative approaches combining cultural heritage preservation, ecological sustainability, and evidence-based evaluation.

Keywords: ethnobotany, herbal, integrative medicine, North Macedonia, Thymus plant, traditional medicine

Introduction

Thyme can be primarily categorized by growth, whether upright or creeping. Thymus serpyllum Lamiaceae is a creeping thyme, commonly known as wild thyme, and is widely recognized in European and Mediterranean flora for its traditional medicinal use [1]. Its roots in alternative medicines, culinary traditions, and spiritual rituals cover a rich ethnobotanical heritage [2]. In North Macedonia, a country characterized by various and unique phytogeographic regions and centuries-old traditions in alternative medicine, thyme is valued in local ethnomedicine and manifests cultural identity and community resilience [3,4]. The ethnobotanical usage of thyme in North Macedonia shows a combination of knowledge, spiritual symbolism, and environmental adaptation [5]. Throughout history, thyme has been applied for the treatment of different health conditions, from respiratory conditions and gastrointestinal problems to widespread use as an antiseptic and anti-inflammatory agent [6-8].

Oral transmission of medicinal recipes, as well as historical manuscripts seen especially in Italy, show the use of thyme not only as a medicine, but also as a protective agent against evil spirits, and as an important element in seasonal rituals and social gatherings [9,10]. Despite centuries of traditional knowledge, research on the bioactive compounds and pharmacological effects of thyme has been limited, but this area of research has seen recognition in recent decades [11]. In North Macedonia there is still no serious scientific research on the medicinal usage of this herb. Modern pharmacological research is beginning to clarify the rich phytochemical profile of thyme, and shows essential oils rich in thymol, carvacrol, and various

flavonoids that support its antimicrobial, antioxidant, and anti-inflammatory properties [12-14]. These results have stimulated interest amongst researchers who aim to find and define the middle ground between folk wisdom and therapeutic medicine based on evidence. In addition, the transition to integrative and alternative medicine occurring across the world shows the importance of ethnobotanical resources as potential sources of new alternative therapies [15,16]. It is important to acknowledge that a critical examination of the use of thyme in the past and present day raises important questions about the sustainability, standardization, and bioethical aspects in medicine [17,18].

The widespread collection of thyme from natural habitats, especially at certain times of the year from the mountains carries severe risk to local biodiversity, and may endanger the ecological balance of endemic plant sites where thyme grows successfully [19-21]. On the other hand, the integration of traditional herbal medicines into modern medicine practice requires serious and rigorous pharmacological validation, comprehensive toxicological assessments, and serious clinical trials to determine the safety and efficacy of the thyme [22,23]. In this context, North Macedonia offers a location for research where traditional herbal knowledge continues in rural communities, while facing the pressures of modernization, globalization, and changing demands from healthcare. An understanding of the ethnobotanical importance and alternative applications of thyme, along with its developed therapeutic potential, is important not only for the preservation of immaterial cultural heritage, but also for informing contemporary biomedical research and public health strategies [24-26].

This research attempts to show a comprehensive and rigorous examination of the ethnobotanical heritage and current developments in alternative medicine of wild thyme in North Macedonia. Through the synthesis of historical and ethnographic evidence with contemporary pharmacological knowledge, this research seeks to show the role of this symbolic plant within families, showing its great and persistent importance, as well as future perspectives in the broader context of world ethnopharmacology and innovations in healthcare from the context of alternative medicine.

Materials and Methods

1. Study design and setting

This research used a descriptive-analytic cross-sectional research design to assess the traditional knowledge, current usage, and cultural significance of wild thyme in North Macedonia. Data collection was performed between 3 June 2024 and 30 June 2025 (until 12:00) through an online questionnaire distributed nationwide.

2. Participants and sampling

There were 182 participants who were recruited through online convenience sampling from urban and rural areas, with the intention of including variation in gender, age, and regional distribution. The sample included 128 women (70%) and 54 men (30%) whom were 18 years and older with the majority falling within the 26-40 age group. Participants were represented from all eight regions of North Macedonia, with higher participation from the Pelagonia and Eastern regions. Due to the electronic distribution of the questionnaire, the sample was weighted toward urban residents (89%) and persons with internet access. Consequently, the results represent a national, urbanized form of traditional knowledge, and digitally mediated ethnobotanical practices rather than a true representation of the target population. Rural, elderly, and digitally less connected populations may be underrepresented. The research should therefore be interpreted as an exploratory cross-sectional assessment.

3. Data collection instrument

Data were collected using a structured questionnaire based on a literature review and preliminary qualitative interviews. The questionnaire was formed with several sections including demographic information, sources of information about medicinal plants (family traditions, internet, books, health workers), ethnobotanical trends of wild thyme use such as preparation methods, frequency and duration of use, health conditions treated with wild thyme, practice and places for self-collection of wild thyme (mountainous areas, fields, home gardens), and perception of efficacy and safety of wild thyme preparations. The questionnaire included closed and open-ended questions in order to allow for quantitative analysis, as well as qualitative insights into cultural habits and individual experiences.

4. Data collection procedure

The survey was conducted using an electronic platform to increase the reach and involvement of participants. The confidentiality of the data and voluntary participation were strictly maintained. The questionnaire consisted of structured categorical items and descriptive questions designed to capture ethnobotanical practices rather than multi-item psychometric scales measuring a single latent construct. Therefore, internal consistency reliability metrics such as Cronbach's alpha were not applicable. Content validity was supported through literature review and alignment with existing ethnobotanical survey frameworks. Prior to dissemination, the questionnaire was reviewed for clarity and comprehensibility. The full survey instrument is provided in Supplementary Materials.

5. Data management and statistical analysis

All collected data were systematically coded and entered manually into a database for analysis. Statistical analyses were conducted using SPSS Version 27.0 (IBM Corp., Armonk, NY, USA) - and R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria) to assess descriptive characteristics and inferential associations. Descriptive statistics summarized demographic traits, usage patterns, and information sources. Chi-square test was used to assess the associations between categorical variables, while the Kruskal-Wallis test was used to evaluate regional differences in duration of wild thyme use, and reported median scores and interquartile ranges. Cluster analysis, supported by principal component analysis was applied to find user profiles based on multidimensional patterns in usage, collection behavior, and knowledge sources. Dimensionality reduction through principal component analysis enabled visualization of participants' similarity patterns. Qualitative analysis of open-ended responses was used to place contextual information into traditional preparations, therapeutic beliefs, and perceptions of efficacy. For inferential regional comparisons, regions with fewer than 10 participants were excluded from comparative statistical testing to avoid unstable estimates and violation of minimum cell assumptions. These regions were retained for descriptive reporting but were not included in inferential regional analyses.

Results

The study included 182 participants, predominantly female (70.33%) from 26 to 40 years (51.1%; Table 1). Most of the participants resided in urban areas (89.01%), whilst rural participants represented 10.44% of the sample. Only 1 participant reported dual residence (0.55%). The age distribution indicated that the majority of participants belonged to the economically active population, with limited representation of people over 60 years (2.7%).

The distribution of participants was among the eight regions of North Macedonia (Figure 1). The data showed a dominance of participants from the Pelagonia region (33%) and the Eastern region (32.4%), representing over 65% of the total sample. The Skopje region followed with 11.5% of participants. The Skopje region is urban with a greater access to online surveys and information dissemination than rural regions, and there is easy access of natural medical plants that grow on the Skopska Crna Gora mountain. The Northeastern (9.9%) and Southwestern (7.7%) regions contributed moderately, while the Southeastern (2.8%), Vardar (1.6%), and Polog (1.1%) regions showed minimal representation. Higher representation from the Pelagonia and Eastern regions may indicate a more preserved cultural relationship with wild thyme due to rural traditions, local biodiversity, and stronger oral knowledge transmission.

Family and ancestral knowledge are the main source of information about medicinal plants amongst the

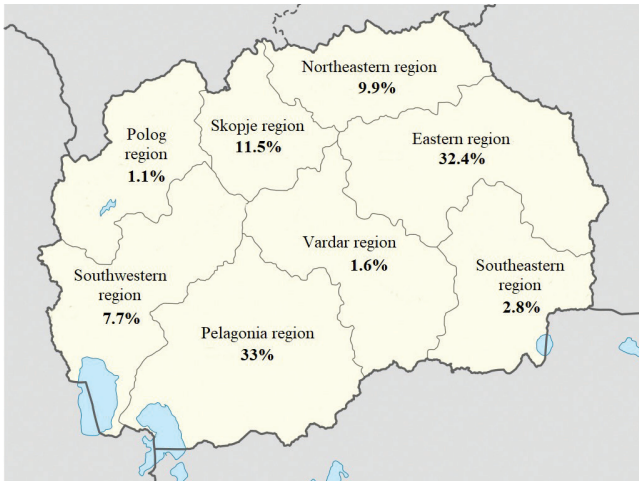

Figure 1. Regional distribution of study participants across the eight statistical regions of North Macedonia. Reproduced from Wikimedia Commons under the Creative Commons Attribution-ShareAlike 3.0 (CC BY-SA 3.0) license.

Table 1. Sociodemographic and Residence Characteristics of Participants

Variable	Category	*n*	%
Gender	Female	128	70.33
	Male	54	29.67
Age (y)	18-25	36	19.80
	26-40	93	51.10
	41-60	48	26.40
	> 60	5	2.70
Place of residence	Urban	162	89.01
	Rural	19	10.44
	Both	1	0.55

Table 2. Primary Sources of Information about Medicinal Plants amongst Respondents

Source of information	*n*	%
Family / ancestors	68	37.36
Internet	32	17.58
Family / ancestors and internet	19	10.44
Family / ancestors, internet, and books	12	6.59
Books	8	4.40
Television / radio	4	2.20
Other combinations and specialized sources	49	26.93

participants (37.36%), suggesting a strong preservation of ethnobotanical traditions in North Macedonia (Table 2). This result establishes the concept of vertical knowledge transfer in which herbal practices and traditional remedies are passed down intergenerationally within families, guaranteeing continuity and cultural resilience. The internet was the second most cited response (17.58%). The combination of family knowledge and online resources (10.44%) showed an integrative approach where traditional and modern information sources can complement each other, improve trust and enhance perceived credibility among users. Books and old media like television and radio had smaller shares (4.4% and 2.2%, respectively), which may indicate a reduced reliance on classical print and broadcast channels in favor of new media, a more interactive or personalized mode of learning. The relatively modest contribution of healthcare workers and herbal pharmacists (26.93%) in providing information to the respondents in the survey show an opportunity to strengthen formal public health education and professional guidance about the usage of medicinal plants.

The majority of the participants (89.56%) reported using wild thyme in the form of tea, showing its strong cultural integration as a traditional herbal infusion in North Macedonian families (Table 3). This matches with broader Mediterranean and Balkan herbal practices, where aromatic infusions are favored for their medicinal and calming properties. Culinary use was the second most common application (5.49%), suggesting a secondary but important role in daily diets, contributing both to flavor, and perceived health benefits. Other methods such as gargling with infusions of wild thyme (1.65%), tinctures or drops (1.10%), and cosmetic preparations (0.55%) appeared insignificant, and showed a restricted variety in the usage of the wild thyme beyond customary methods of intake. The strong preference for tea may show accessibility and cultural familiarity, and thus, points to the need for public health education about preparation methods for wild thyme, dosage, and potential interactions with conventional medications. The minimal use of cosmetic or pharmaceutical forms of wild thyme opens the potential for product innovation and applications, especially in functional food and natural skincare sectors in this country.

Most participants (57.69%) reported using Macedonian wild thyme for respiratory-related conditions including treatment of a cough, a cold, a sore throat, and other respiratory infections (Table 4). Treatment of stress- and sleep-related problems were reported by 24.73% of participants, while 21.98% indicated preventive use of wild thyme e.g., immune support. Treatment of digestive problems were reported by 12.09% of the participants. Since multiple responses were allowed, percentages exceed 100%. The restructuring of health categories into broader clinical groups may improve interpretability and define the multidimensional nature of treatment with wild thyme amongst participants.

Table 3. Methods of Using Macedonian Wild Thyme amongst Respondents

Method of use	*n*	%
Tea	163	89.56
Culinary use	10	5.49
Gargle / throat rinse	3	1.65
Other	3	1.65
Tinctures / drops	2	1.10
Cosmetic products (soap, creams)	1	0.55

Table 4. Health Problems for Which Respondents Use Macedonian Thyme

Health problem	*n*	%
Respiratory conditions	105	57.69
Stress or sleep related	45	24.73
Preventive usage (e.g., immune support)	40	21.98
Digestive problems	22	12.09
Other	26	14.29

Since multiple responses were allowed, percentages exceeded 100%.

A large number of participants (47.8%) reported self-collection of wild thyme, indicating an ongoing dependence on direct interaction with natural habitats (Table 5). Amongst the self-collectors, mountain regions were the most common source of collection (73.26%) likely due to the plentiful amount of wild thyme in higher altitudes, and the cultural tradition of mountain herb gathering in North Macedonia. Fields and meadows were reported by 25.58% of self-collectors, suggesting accessibility and local biodiversity in predominantly rural or peri-urban regions. Only 1 participant (1.16%) reported harvesting from a home garden, suggesting limited domestication efforts and a stronger preference for collection of wild thyme in mountain areas. On the other hand, 52.2% of participants preferred to purchase, rather than collect, wild thyme from markets, pharmacies, or specialized stores, suggesting a pattern of urbanization, reduced availability of natural collection areas, and possibly a shift towards convenience and regulated supply chains.

The distribution of self-collecting practices for wild thyme across the eight regions of North Macedonia is shown in Table 6. The Southeastern (80.0%) and Northeastern (77.8%) regions show the highest prevalence of self-collecting. In contrast, Pelagonia shows the lowest self-collection rate (28.3%), with a reliance on purchasing (71.7%). This result may be due to urbanization, greater market availability, and

Table 5. Practice of Self-Collecting of Thyme and Collection Sites amongst Respondents

Practice and location	*n*	Self-collectors (%)
Mountain areas	63	73.26
Fields / meadows	22	25.58
Home garden	1	1.16
Total self-collectors	87	100
Do not collect (bought from a market, pharmacy, or store)	95	52.2

Since multiple responses were allowed, percentages exceeded 100%.

Table 6. Relationship Between Region and Practice of Self-Collecting Macedonian Wild Thyme

Region	Self-collected (%)	Purchased (%)
Southwestern	8 (57.1)	6 (42.9)
Southeastern	4 (80.0)	1 (20.0)
Vardar	1 (33.3)	2 (66.7)
Eastern	33 (55.9)	26 (44.1)
Pelagonia	17 (28.3)	43 (71.7)
Pelagonia & Southwestern	1 (100.0)	0 (0.0)
Polog	1 (100.0)	0 (0.0)
Northeastern	14 (77.8)	4 (22.2)
Skopje	8 (38.1)	13 (61.9)

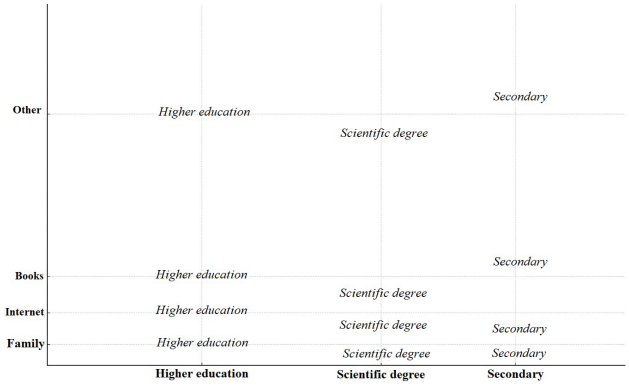

Figure 2. Association between education level and primary sources of information on medicinal plants. The X-axis represents education level and the Y-axis represents primary sources of information.

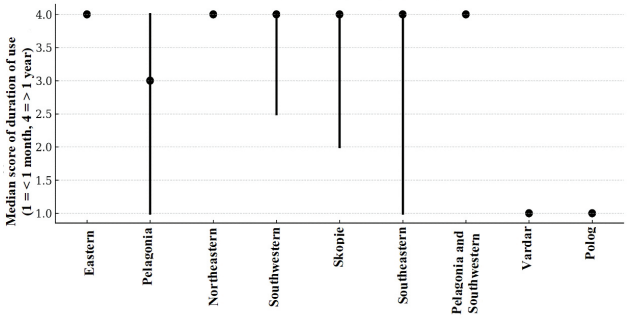

Figure 3. Regional differences in the duration of treatment use of wild thyme use across North Macedonia. The X-axis represents the statistical regions of North Macedonia.

changing socio-cultural preferences. The Skopje region also showed a higher tendency to purchase wild thyme (61.9%) which may be due to its urban character and reduced direct access to wild-growing areas. Regions such as Polog and the mixed Pelagonia-Southwestern area reported 100% self-collection.

The relationship (χ^2 = 188.36) between education level and preferred sources of information on medicinal plants is shown in Figure 2. Participants with a secondary education relied on family and ancestral knowledge (57.1%), which indicates a strong preservation of traditional oral transmission of knowledge. In contrast, people with a higher education showed more varied modes of accessing information, integrating family advice (25.5%), internet resources (20.6%), and combined sources like family and internet (12.7%). This trend showed the role of higher education in supporting a hybrid approach - traditional knowledge with modern resources. Participants with a scientific degree, although fewer in number, showed the highest tendency to combine multiple sources. This shows evaluation and triangulation of information; a behavior typically associated with higher scientific literacy. All participants with a primary education relied on family knowledge, and this revealed limitations in access to or reliance on modern information.

The median ranks of duration of treatment use of wild thyme amongst participants from different regions in North Macedonia, with 95% confidence intervals, is shown in Figure 3. The analysis showed statistically significant regional differences (H = 20.72), suggesting that geographical and cultural contexts are important in the prolonged treatment use of herbal remedies. Participants from the Northeastern and Southeastern regions reported longer median durations, suggesting a stronger preservation of traditional practices, and easier access to wild harvesting areas. In contrast, participants from urbanized regions such as Skopje and Pelagonia with the major cities like Bitola and Prilep showed shorter usage duration of treatment, this may be influenced by lifestyle factors, market dependency, and reduced direct participation with local flora.

Table 7. Median Rank and Interquartile Range for Duration of Use of Macedonian Wild Thyme by Region

Region	Median rank	Q1 (25%)	Q3 (75%)
Southwestern	4.0	2.5	4.0
Southeastern	4.0	2.0	4.0
Vardar	1.0	1.0	1.0
Eastern	4.0	4.0	4.0
Pelagonia	3.0	1.0	4.0
Pelagonia and Southwestern	4.0	4.0	4.0
Polog	1.0	1.0	1.0
Northeastern	4.0	4.0	4.0
Skopje	4.0	1.75	4.0

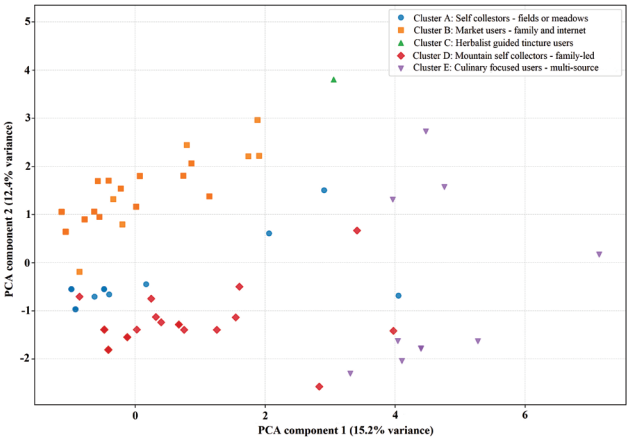

Figure 4. Exploratory 2-dimensional visualization of wild thyme usage patterns based on K-meansclustering and principal component analysis.
PCA = principal component analysis; K-means = K-means clustering algorithm.

The Eastern, Northeastern, Pelagonia, and Southwestern regions show high median ranks (4.0) - longer-term treatment usage of wild thyme amongst participants (Table 7). On the other hand, Vardar and Polog regions have the lowest median ranks (1.0) - minimal or short-term use. The broader interquartile range in Pelagonia and Skopje show greater heterogeneity in user experience, possibly reflecting mixed urban and rural subgroups. In contrast, Vardar and Polog regions show more uniform treatment use tendencies.

An exploratory 2-dimensional visualization of wild thyme usage patterns derived from K-means clustering (k = 5) based on method of use, collection behavior, and information sources is shown in Figure 4. The selection of k = 5 was guided by interpretability and supported by a moderate average silhouette coefficient (0.32), indicating acceptable but not strong cluster separation within this convenience sample. Multidimensional categorical variables were standardized and projected onto the first 2 principal components, which together explained 27.6% of the total variance (PC1: 15.2%; PC2: 12.4%). Each point represented an individual participant and clusters showed heterogeneous usage profiles. The Principal Component Analysis projection eases visualization of participant similarity patterns but does not imply definitive user typologies. In that matter, the clustering should be interpreted as descriptive and exploratory rather than confirmatory.

Discussion

Wild thyme used medicinally has roots in alternative medicine and has rich ethnobotanical heritage in North Macedonia [3,4]. This survey study showed not only the usage of wild thyme in North Macedonia, but how traditional and modern views of this medical plant have been integrated across the regions. However, given the predominance of urban participants in this survey, these results should be interpreted as contemporary urban-adapted forms of traditional knowledge rather than purely rural ethnobotanical practices.

The results show an established deep cultural use of wild thyme as a medicinal and culinary plant, while revealing the developing dynamics of information and application amongst different demographic groups. The high prevalence of traditional knowledge transmission through family shows the resilience of ethnobotanical heritage despite rapid societal modernization. In addition, the increasing reliance on digital sources, especially amongst younger participants and those with a higher education, shows a transition towards hybrid learning and adoption patterns. Regional disparities in self-collection practices and duration of treatment use of wild thyme shows that access to natural habitats, local biodiversity, and cultural continuity are important. The statistically significant differences in duration of use amongst regions support the concept that traditional collecting and herbal preparation skills are more active in rural and semi-rural areas of North Macedonia. Cluster analysis also showed the heterogeneity of user profiles, differentiating between traditional knowledge of self-collectors and other consumers who rely on acquisition through markets and online resources.

One study on ethnobotanical research, in northern Greece, showed information about the traditional use of medicinal plants amongst different population groups in Greece. Their work demonstrated the application of herbal remedies for respiratory tract ailments and skin disorders, paralleling the uses of thyme documented in this current research [27].

The results in this current study are consistent with another ethnobotanical study which documented the predominant use of medicinal plants in the Sharr

Mountains primarily as teas for respiratory conditions. Similarly, thyme tea was the dominant preparation method in this current study sample, with respiratory complaints representing the main indication for treatment [28]. Both studies show the persistence of family-based knowledge transmission as the primary pathway of ethnobotanical continuity and this research focused on rural multiethnic mountain communities, but the current study showed predominantly urban, and digitally influenced patterns of use. The emergence of hybrid knowledge sources combining family traditions and internet resources distinguishes contemporary usage from earlier rural model studies.

One ethnopharmacological research study from Northwestern Algeria showed the persistence of traditional plant-based therapies, especially using thyme within the Lamiaceae family, where Thymus vulgaris showed high cultural relevance (RFC = 0.124) [29]. While the Algerian study focused on dermatological conditions and topical preparations, the results in this current study showed results for respiratory and preventive uses of wild thyme in tea form. Both research studies identified the role of traditional knowledge transmission and the therapeutic versatility of thyme species. However, unlike the herbalist-based Algerian survey, this current research study showed broader community-level usage patterns within an integrative medicine context.

Cultural transmission and practical experience in traditional medicine preparations were apparent from the participants of this current research study. Traditional medicinal knowledge is transmitted orally across generations, with elders playing an important cultural role in teaching the preparation and use of herbal remedies. This intergenerational exchange ensures the preservation of cultural heritage and the continuity of effective traditional health practices.

One participant within this current research study shared her traditional experience: “When my daughter had scabies, during the period of an intense outbreak, there was severe itching, and noticeable nervousness. The anxiety calmed down after using wild thyme tea and the itching was relieved.” This observation connects with the experimental results of 1 researcher who developed a topical herbal formulation containing thyme essential oil which has potent anti-scabies activity against Demodex and Sarcoptes parasites. Their formulation showed effective parasitic eradication with no adverse effects, supporting the ethnobotanical use of thyme for skin conditions [30].

Another participant in this current study reported having ulcerative colitis, noting that many common spices such as Vegeta all-purpose seasoning and black pepper worsened their condition. This participant stated that wild thyme was well tolerated and used regularly as a preferred seasoning. This shows the potential of the thyme as a gentle and beneficial alternative for people with gastrointestinal sensitivities, potentially aligning with its recognized anti-inflammatory properties and traditional usage in digestive health. Another respondent described a traditional wild thyme tea preparation was used to soothe cough: “ Two tablespoons of dried wild thyme and 2 tablespoons of mint are boiled in 300 mL of water for 15 minutes. After straining, honey and freshly squeezed lemon are added, mixed well, and refrigerated. The tea is consumed 1 to 2 tablespoons daily. In addition, thyme is used as a kitchen spice and as compresses for skin infections.” This preparation showed the contribution of thyme in local medicinal and culinary practices, and revealed the integration of herbal remedies in everyday life.

Clinical evidence from a randomized controlled trial showed that oral treatment with a thyme-ivy extract combination reduced coughing fits and eased recovery in acute bronchitis patients [31], which may indicate the traditional use of thyme for respiratory ailments reported by the respondents in this current study.

Another participant described a traditional preparation where several sprigs of Macedonian wild thyme are steeped in homemade brandy, called rakija, and stored in a dark place for 1 month. The infusion is consumed in small quantities orally but is more commonly used topically as an application on painful areas such as knees and joints. This practice shows the use of wild thyme in folk medicine, both internally and externally, supportive of its reputed analgesic and anti-inflammatory properties. One trial showed that topical application of thyme gel improved pain, stiffness and physical performance in osteoarthritis patients, effects that connect with the testimonial of the participant in this current study, who reported using thyme to manage joint pain and found it to be an effective and well-tolerated remedy [32].

Another participant reported recovering quickly from pneumonia with the help of honey derived from Macedonian wild thyme. He described boiling thyme to prepare a tea, straining it and then adding a large amount of honey to create a syrup, which was used as the therapeutic agent. In addition, 1 randomized trial showed that inhalation therapy with Thymus vulgaris essential oil improved airway status and oxygen saturation in patients under mechanical ventilation by reducing airway secretions and improving mucociliary clearance [33].

These individual testimonials represent self-reported ethnobotanical experiences and should be interpreted cautiously. They do not provide clinical proof of efficacy and were not validated through diagnostic or therapeutic monitoring. Rather, they serve as culturally grounded, preliminary observations that may inform the design of controlled clinical trials investigating the therapeutic potential of the preparations of thyme.

In terms of the implications for integrative medicine practice, these results provide information into how

wild thyme is currently used in North Macedonia and allow cautious translation into integrative medicine contexts. Respiratory use was the most frequently reported indication, which aligns with existing evidence that supports thyme-based preparations for acute bronchitis and productive cough [34,35]. At least 1 randomized controlled trial has shown efficacy in reducing coughing episodes in acute respiratory infections, providing partial evidence-based support for this traditional application. In contrast, preventive use, stress-related applications, and digestive indications reported by participants are primarily supported by preclinical or limited clinical evidence. These uses may be biologically plausible given the plant's phytochemical profile, but robust human trials specific to Thymus serpyllum remain limited.

From a safety perspective, self-collection from mountainous regions raises concerns regarding plant misidentification, contamination, and variability in phytochemical composition. Clinicians should advise patients to ensure care in the identification of the correct botanical plant, and to exercise caution in the treatment of people with known allergies to Lamiaceae species. Standardized preparations may offer greater safety and dosage consistency compared with uncontrolled wild harvesting. Generally, wild thyme may be considered a complementary option for mild respiratory symptoms within an integrative care framework, but it should not replace conventional treatment in serious infections or chronic conditions. Healthcare professionals in North Macedonia may benefit from open dialogue with patients regarding herbal use, especially in rural areas where self-collection practices remain common.

This research has several limitations. The use of online convenience sampling survey resulted in a sample imbalanced toward urban residents (89%) and women (70%). Consequently, the results show urbanized forms of traditional knowledge, including hybrid information pathways combining intergenerational transmission and digital sources, rather than a nationally representative population from rural and urban areas. Rural, elderly, and digitally less connected groups may be underrepresented, limiting generalizability of these results. The cross-sectional design and reliance on self-reported data may introduce recall and reporting biases. Although efforts were made to include participants from all eight regions of North Macedonia, certain regions such as Polog and Vardar were underrepresented. Therefore, the results should be interpreted as exploratory rather than population-based. An additional limitation is the absence of phytochemical or pharmacological verification of the wild thyme preparations reported by participants. While ethnobotanical data provide valuable cultural information, laboratory validation would strengthen conclusions regarding safety, standardization, and therapeutic efficacy.

This study did not collect quantitative data on harvesting volumes, frequency, or ecological impact which would have addressed biodiversity concerns related to wild harvesting. The results are therefore limited to self-reported collection practices without objective assessment of environmental pressure. Future research should prioritize ecological field studies and quantitative evaluation of the intensity of harvesting, especially in mountainous regions identified as primary collection sites. Future research should incorporate stratified or mixed-method sampling strategies to improve rural and elderly group representation. Longitudinal and experimental designs are needed to examine associations between wild thyme use and specific health outcomes. Interdisciplinary approaches integrating ethnobotany, pharmacognosy, ecology, and clinical sciences would further clarify the sustainability, safety and evidence base of wild thyme use within integrative medicine contexts.

Conclusion

This research provides exploratory information on contemporary perceptions and usage patterns of Thymus serpyllum amongst a predominantly urban sample in North Macedonia. The results showed that the majority of participants use thyme as tea for respiratory conditions, but also for general immune support and stress relief. The strong reliance on family knowledge and ancestral information shows the resilience of oral transmission systems, whilst integration of digital sources shows a dynamic shift towards hybrid information pathways amongst younger and more educated people. Regional disparities in self-collection practices and differences in the duration of use across regions reveals the role of local ecological contexts and cultural continuity in directing ways of herbal use. The preference for self-collection from mountainous regions showed a deep-rooted bond between people and their natural environment. However, trends of urbanization and market dependence are evident, especially in urban centers such as the Skopje region and Pelagonia with major cities like Prilep and Bitola.

Advanced statistical analyses showed evidence for the heterogeneity of the profiles and showed the coexistence of traditional and modern strategies for ethnobotany and alternative medicine. Rich qualitative data extracted from open-ended responses showed the experiences and personal connections that people have with thyme. It showed the position of wild thyme not only as a medicinal resource, but also as a symbol of cultural identity and resilience.

While this research confirms the cultural and health relevance of wild thyme in North Macedonia, it also seeks the urgent need for integrative approaches that combine alternative medicine with pharmacological validation, conservation strategies, and public health education. Such

interdisciplinary effort is important to sustain the use of this valuable medicinal plant, protect biodiversity, and strengthen the connection between traditional wisdom and medicine based on evidence.

Supplementary Materials

Supplementary materials are available at doi: https://doi.org/10.56986/pim.2026.06.004.

Conflict of Interests

The author has no conflicts of interest to declare.

Author Use of AI Tools Statement

The author used generative AI tools solely for minor language editing and improvement of readability during manuscript preparation. All scientific content, data analysis, interpretations, conclusions, and final responsibility for the manuscript remain entirely with the author.

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Ethics Statement

This research involved non-invasive, anonymous online data collection using structured questionnaires and voluntary participation. According to the institutional guidelines of the Higher Medical School - Bitola, University "St. Kliment Ohridski" - Bitola, formal ethical approval was not required due to the anonymous and minimal-risk nature of the study. All procedures were conducted in accordance with the Declaration of Helsinki. Participants were informed about the purpose of the research and were guaranteed confidentiality and anonymity. They retained the right to withdraw at any time without penalty. Data were securely managed and used exclusively for research purposes. Participation was restricted to persons from 18 years and older. Age eligibility was implemented through a mandatory screening question at the beginning of the online survey and participants who did not confirm that they were ≥18 years of age were not allowed to proceed.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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