BIODIVERSITAS
Volume 26, Number 8, August 2025
Pages: 4017-4022

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d260830

Short Communication: Community knowledge and uses of *sambiloto* (*Andrographis paniculata*) in an Urban Herbal Village, Surabaya, East Java, Indonesia

RASYIDAH ULFA♥, FATMAH♥♥, SUYUD WARNO UTOMO
School of Environmental Science, Universitas Indonesia. Jl. Salemba Raya, UI Salemba Campus No. 4 Kenari, Senen, Central Jakarta 10430, Jakarta, Indonesia. Tel./fax.: +62-21-31930251, ♥email: rasyidah.ulfa@ui.ac.id, ♥♥ffatmah@yahoo.com

Manuscript received: 14 May 2025. Revision accepted: 19 August 2025.

Abstract. *Ulfa R, Fatmah, Utomo SW. 2025. Short Communication: Community knowledge and uses of* sambiloto *(*Andrographis paniculata*) in an Urban Herbal Village, Surabaya, East Java, Indonesia. Biodiversitas 26: 4017-4022. Andrographis paniculata*, commonly known as *sambiloto* or the bitter, is a widely recognized medicinal plant used traditionally across Asia. Known for its bitter taste and pharmacological benefits, this plant is commonly used to treat fever, influenza, inflammation, diabetes, and infections. Despite its broad health applications, the level of public knowledge and actual utilization of *A. paniculata* in urban areas remains understudied. This study examined the correlation between community knowledge and practical uses of *A. paniculata* in Kampung Herbal Nginden, an urban herbal village in Surabaya, East Java, Indonesia. A mixed-methods approach was used, including structured questionnaires with 105 respondents and in-depth interviews with key community informants. The results showed that 52% of respondents demonstrated high knowledge of *A. paniculata*, yet only 44% actively utilized the plant in their daily life. A significant correlation was found between knowledge and utilization (p: 0.001), with high-knowledge individuals being 7.58 times more likely to use the plant. These findings highlight the need for increased community awareness and educational interventions, which are crucial for supporting the sustainable use of medicinal plants in urban settings. Community-based approaches, such as Kampung Herbal Nginden, provide a valuable foundation for preserving urban ethnobotanical practices, where cultural practices are often challenged by modernization and pharmaceutical dominance. Promoting ethnobotanical knowledge and practical use in urban environments is essential not only for public health but also for conserving cultural heritage and medicinal plant biodiversity.

Keywords: *Andrographis paniculata*, ethnobotany, Kampung Herbal Nginden, traditional medicine in cities, urban ethnomedicine

INTRODUCTION

Biodiversity provides a foundation for ecosystem health, resilience, and well-being. Plants are vital for maintaining ecological functions, such as nutrient cycling, climate regulation, and water purification (Miller and Spoolman 2016; Babich et al. 2020). Plants also offer extensive medicinal benefits and have been traditionally used across cultures for the preservation of health and treatment of illness. Medicinal plants are especially important in developing countries where access to formal healthcare may be limited, and plant-based treatments remain the first line of defense (Chen et al. 2016). These plants are integrated into traditional health systems, such as *jamu* in Indonesia, and are commonly found in household gardens, local markets, and herbal clinics. Ethnobotanical knowledge, passed down through generations via oral traditions, ensures the preservation and sustainable use of these resources. However, this knowledge is increasingly threatened because of rapid urbanization, modernization, and the erosion of intergenerational cultural transmission (Ihemezie et al. 2021; Wibowo et al. 2021).

One widely known and scientifically proven medicinal plant in Indonesia is *Andrographis paniculata* (Burm.fil.) Nees, commonly known as *sambiloto*. This species belongs to the Acanthaceae family and is valued for its intense bitter taste and broad therapeutic benefits. Traditionally, it has been used to treat fever, influenza, inflammation, infection, and gastrointestinal disorders (Afra and Iskandar 2019; Akilandeswari et al. 2019). Modern pharmacological studies have confirmed that the bioactivity of the major compound, andrographolide, exhibits antiviral, antipyretic, and anti-inflammatory properties (Ilmi et al. 2021; Jiang et al. 2021). Recent studies have explored its role in managing coronavirus disease 2019 (COVID-19) symptoms and enhancing immune responses (Alkandahri et al. 2018; Sa-Ngiamsuntorn et al. 2020).

Despite this wealth of evidence, the practical use of *A. paniculata* in urban areas is declining. Several factors have contributed to this trend, including negative perceptions of the bitter taste, difficulty in proper preparation, lack of validated information, and increasing dependence on synthetic drugs (Jokar et al. 2017; Mayer et al. 2017). Urban living, with its fast-paced cultural and convenience orientation, further diminishes interest in traditional herbal practices, especially when formal instruction is lacking. Moreover, intergenerational transmission of herbal knowledge is eroding. A growing trend shows younger urban dwellers disengaging from herbal gardens and familial herbal traditions, relying instead on digital resources and institutional healthcare (Dapar et al. 2020; Aziz et al. 2023). Without accessible community-based

initiatives, the momentum for renewed interest in herbal medicines and immune-boosting plants has the risk of diminishing after the COVID-19 pandemic. Communities require education, tools, and institutional support to reestablish medicinal plants in daily life (Ashaolu 2020; Babich et al. 2020; Miyamoto et al. 2021).

Urban herbal villages, such as Kampung Herbal Nginden in Surabaya, East Java, Indonesia, aim to counteract these trends by offering green spaces for cultivation, education, and community bonding around medicinal plants (Dutta et al. 2021). Launched in 2015, the program encourages residents to grow, process, and utilize herbs, such as *sambiloto*, to meet household needs. Given its structured community leadership, periodic workshops, and an emphasis on participatory involvement, Kampung Herbal Nginden serves as a valuable case study for assessing the sustainability of urban ethnobotany.

Although the physical presence of the medicinal plants, such as *sambiloto*, in Kampung Herbal Nginden is evident, it remains unclear how deeply community knowledge translates into practical use. Are residents using *A. paniculata* for effective health maintenance? What barriers hinder broader adoption? To date, few studies have integrated the link between the knowledge and utilization of *A. paniculata* in urban communities. Answering these questions is critical for improving urban ethnomedicine strategies.

The studies aimed to examine the relationship between community knowledge and the practical use of *A. paniculata* in Kampung Herbal Nginden. Specifically, it explored (i) the level of public knowledge of *sambiloto*, (ii) the patterns of its household use, and (iii) the correlation between knowledge and application. By identifying gaps and potential enablers, this research supports evidence-based interventions to strengthen traditional medicine in urban settings, safeguard cultural heritage, and enhance public health resilience.

MATERIALS AND METHODS

Study period and area

This study was conducted between November and December 2023 at Kampung Herbal Nginden, located in Nginden Jangkungan, Jangkungan Village, Sukolilo Sub-district, Surabaya City, East Java Province, Indonesia. Kampung Herbal Nginden, an urban herbal village established in 2015, cultivates over 190 medicinal plants, including *A. paniculata*.

Research design and sampling technique

A mixed-method approach was employed to integrate quantitative and qualitative surveys. The target population consisted of adult residents (≥18 years) living in or near Kampung Herbal Nginden. Respondents were selected using purposive sampling based on their familiarity with the plant and their willingness to participate. In total, 105 respondents completed the survey. In addition, five key informants were chosen for in-depth interviews based on their roles in herbal education or community health services.

Ethical considerations

This study was reviewed and approved by the Ethics Commission of Health Research and Development Sint Carolus School of Health Science. Prior to data collection, informed consent was obtained from all respondents. They were informed about the study objectives, their right to withdraw at anytime, and the confidentiality of their responses. Anonymity was maintained by not collecting any personally identifiable information.

Data collection instruments

Data were collected using a structured questionnaire consisting of closed-ended questions divided into two sections: (i) the respondent's knowledge of *A. paniculata* regarding its benefits, uses, and preparation, and (ii) the frequency and method of practical use. To ensure the clarity and reliability of the instrument, the questionnaire underwent a pilot test with 10 individuals from a neighboring community not included in the final sample. The reliability of the knowledge section was evaluated using Cronbach's Alpha, resulting in a value of 0.76, indicating acceptable internal consistency. Qualitative data were obtained through semi-structured interviews with herbalists, academics, and community leaders.

Data analysis

Qualitative data were analyzed using descriptive statistics and ethnobotanical indices. Community knowledge and practical use of *A. paniculata* were categorized in two levels (high and low) based on cumulative scores from questionnaire items. This binary classification enabled a clearer interpretation of behavioral patterns in relation to knowledge levels.

The quantify ethnobotanical significance, the following formulas were applied:

$$\text{Use Value (UV)} = \Sigma U/N$$

Where, ΣU is the total number of uses reported by all informants and N is the total number of informants interviewed. This index measures the relative importance of the species based on its reported uses.

$$\text{Relative Frequency of Citation (RFC)} = FC/N$$

Where, FC represents the number of respondents citing the use of *A. paniculata* and N is the total sample size. RFC reflects how widely the plant is recognized and used within the community. Values ≥0.50 were interpreted as "high" citation frequency.

$$\text{Informant Consensus Factor (ICF)} = (N_{ur} - N_t) / (N_{ur} - 1)$$

Where, N_{ur} is the number of use reports in a category, and N_t is the number of species used for that purpose. ICF indicates the level of agreement among informants for specific uses.

The statistical relationship between knowledge level and practical use of *A. paniculata* was evaluated using the Chi-square test with a significance level of $p<0.05$.

RESULTS AND DISCUSSION

Respondent's demographics

A total of 105 respondents participated in this study. The demographic profile indicated that 67% of the respondents were female, and 33% were male. Most respondents (66%) aged between 35 and 64 years; 20% aged between 18 and 34 years, and 14% aged 65 years and above. Regarding education, 42% completed senior high school, 36% held a bachelor degree, and 22% had either lower or non-formal education. In terms of occupation, 34% of the respondents were housewives, 11% were civil servants, and 22% were students (Table 1).

Community knowledge of *Andrographis paniculata*

Of the 105 respondents, 55 respondents (52%) demonstrated a high level of knowledge of *A. paniculata* based on their accurate responses to questions concerning its identification, health benefits, traditional use, and preparation methods. Most respondents could distinguish plants based on leaf shape, bitter taste, and common applications in traditional medicine (Figure 1).

The most frequently cited health benefits include treatment for flu (76%), fever (64%), digestive problems (43%), and blood sugar control (27%). The key sources of knowledge were family traditions (42%) and neighbors or friends (41%). In comparison, a relatively small number of respondents gained knowledge from health workers (5%) or digital platforms, such as social media (4%).

Utilization level of *Andrographis paniculata*

Despite moderate to high knowledge levels, only 46 respondents (44%) reported the active use of *A. paniculata* in their households, primarily for the treatment of influenza, fever, and other mild infections. The most common preparation method was boiling fresh or dried leaves to make a decoction (63%), followed by crushing leaves for external application (18%) and use in herbal mixes or "*jamu*" (9%) (Figure 2).

Among the 59 respondents (56%) who did not use the plant regularly, the common reasons were unpleasant bitter taste (43%), uncertainty about the correct preparation or dosage (26%), the preference for over-the-counter pharmaceutical alternatives (21%), and the lack of access to plants (10%). These findings indicate that although knowledge exists, several practical and perceptual barriers limit the plant's routine use in urban households.

Use Value (UV), Relative Frequency of Citation (RCF), and Informant Consensus Scores (ICS)

The Use Value (UV) of *A. paniculata* was 0.74, indicating moderate importance in daily household practices. The Relative Frequency of Citation (RFC) was 0.81, suggesting the plant is widely recognized and cited for its medicinal uses. These values suggest the plant maintains cultural relevance in the community.

The Informant Consensus Score (ICS) was highest for usage in treating colds (0.92), followed by digestive disorders (0.87) and fever (0.83), demonstrating strong agreement among respondents on the main uses of *A. paniculata* (Table 3). A high ICS (approaching 1.0) indicates a well-established consensus on the plant's efficacy and trusted applications.

These results confirm that *A. paniculata* holds medicinal significance in this urban community, particularly for treating common ailments. However, despite this recognition, practical usage is still lower than expected, highlighting the knowledge-practice gap discussed further in the next section.

Correlation between knowledge and utilization

A Chi-squared test was conducted to determine the association between knowledge and practical use. The results indicate a statistically significant relationship (p: 0.001) between the two variables. Among the 55 respondents with a high level of knowledge, 36 (65.5%) actively used *A. paniculata*, compared to only 10 of 50 (20%) in the low-knowledge group. The OR (7.58; 95% confidence interval: 3.12-18.42) indicated that respondents with a high level of knowledge were 7.58 times more likely to use *A. paniculata* than those with a low level of knowledge; this suggests that enhancing awareness and accurate understanding of plants may lead to a corresponding increase in sustainable utilization (Table 2).

Table 1. The profile of respondents

Respondent characteristics	Number (n: 105)	Percentage (%)
Gender		
Man	35	33
Woman	70	67
Age		
20-34 years	22	21
35-49 years	35	33
50-64 years	35	33
65-79 years	12	12
>80 years	1	1
Education		
Elementary school	9	8
Junior high school	3	3
Senior high school	44	42
Diploma	5	5
Bachelor	38	36
Others	6	6
Occupation		
Self-employed	35	33
Housewife	36	34
Employee	9	9
Retired	6	6
Civil servants	0	0
Students/colleges	8	8
Others	11	10

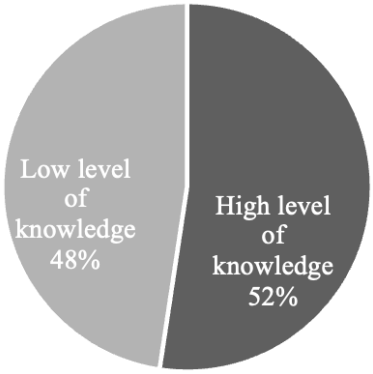

Figure 1. Level of respondents' knowledge of *Andrographis paniculata*

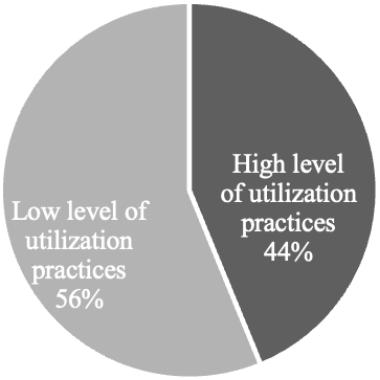

Figure 2. Level of utilization of *Andrographis paniculata* by respondents

Discussion

This study not only confirms a significant positive correlation between community knowledge and the practical uses of *A. paniculata* among residents of Kampung Herbal Nginden, Surabaya, but also sheds light on the practical implications of this knowledge. Despite 52% of respondents being categorized as having high knowledge, only 44% actively practiced its use in urban ethnobotanical literature (Jokar et al. 2017; Yeganeh et al. 2022). This gap suggests that knowledge also does not ensure behavioral application, especially in urban contexts where modern lifestyles, pharmaceutical options, and changing social dynamics alter health behaviors (Ayuningrum et al. 2024; Geng et al. 2025).

One of the primary deterrents on the practical use of *A. paniculata* by urban community was the bitter taste, which 43% of non-users reported as a barrier to use. This finding resonates with studies in Indonesia and elsewhere, highlighting the global relevance of our research. Taste is a critical factor influencing the acceptability of herbal remedies (Mayer et al. 2017; Yunus and Dida 2017). Similar perceptions have been observed in communities in Central Java, Indonesia (Darmastuti et al. 2024) and Jambi, Indonesia (Novriyanti et al. 2021). Negative sensory experiences reduce the likelihood of consumption despite positive health beliefs, a phenomenon that transcends geographical boundaries.

Lack of knowledge in preparation method was the second most cited barrier (26%), indicating uncertainty about dosage, formulation, and application methods. This challenge is common in urban settings, where traditional knowledge transmission has weakened, especially among younger generations (Santhyami et al. 2024; Ullah et al. 2025). While traditional medicine has deep cultural roots, its practical application in cities requires bridging knowledge gaps through formal education and accessible guidance materials. Studies in Iloilo City, Philippines (Cordero et al. 2025) and Surakarta, Indonesia (Ayuningrum et al. 2024) similarly note that familiarity with medicinal plants does not translate into confident usage without training or community health support.

In Kampung Herbal Nginden, intergenerational oral knowledge transmission remains dominant, with family (42%) and neighbors (41%) serving as primary informational sources. This informal learning model is valuable for sustaining tradition but may lack accuracy or scientific rigor (Miyamoto et al. 2021; Wibowo et al. 2021). Previous studies in urban home gardens in Central Java highlight that unstructured information flow can lead to the erosion or distortion of knowledge over time (Darmastuti et al. 2024). The need to incorporate herbal education into urban public health curricula and community workshops is increasingly recognized as a strategy to sustain plant use while ensuring safety and efficacy (Fahmi et al. 2025).

While *A. paniculata* is extensively studied and known for its pharmacological properties, ranging from anti-inflammatory and antidiabetic to immunomodulatory and antiviral (Sa-Ngiamsuntorn et al. 2020; Jiang et al. 2021; Kumar et al. 2021), its use remains inconsistent in urban communities. This may stem from perceived superiority of pharmaceuticals, easier access to modern medicine, and declining trust in traditional remedies. Pozdnyakova et al. (2025) found similar skepticism toward herbal medicine among urban populations in Central Asia, particularly where health systems emphasize clinical approaches over traditional ones.

At the global level, urban ethnobotany has emerged as a vital research field to understand how medicinal plant use adapts to urbanization (Geng et al. 2025). Cities like Surabaya, with initiatives like Kampung Herbal Nginden, exemplify how urban communities can reclaim traditional knowledge through collective efforts. Such spaces not only preserve biodiversity but also strengthen social cohesion, cultural identity, and community health (De Meyer et al. 2025). These initiatives, however, required support from institutions, including local governments, health agencies, and educational institutions, to ensure sustainability and reach.

Table 2. Correlation between community knowledge and utilization

Community knowledge	Utilization practices				Total		OR (95% CI)	P value
	Low		High		n	%		
	n	%	n	%				
Low	40	80	10	20	50	100	7.579	*0.001
High	19	34.5	36	65.5	55	100	(3.118-18.424)	
Total	59	56.2	46	43.8	105	100		

Note: *p<0,05

Table 3. Use Value (UV), Relative Frequency of Citation (RCF), and Informant Consensus Scores (ICS)

Category	UV	RCF	ICS
Colds	0.72	0.80	0.92
Digestive disorders	0.76	0.78	0.87
Fever	0.75	0.77	0.83
General immunity	0.68	0.75	0.80
Diabetes management	0.60	0.66	0.75

Women play a pivotal role in urban ethnobotanical practices. This study found that female respondents were more likely to have practical experience using *A. paniculata*, which resonates with other findings from Surabaya (Safitri et al. 2021) and Jambi (Novriyanti et al. 2021). In both rural and urban contexts, women often manage home gardens, prepare remedies, and transmit herbal knowledge, making them key stakeholders in herbal health strategies. Radha et al. (2025) argue that empowering women in ethnobotanical knowledge systems can increase community resilience and biodiversity awareness.

Beyond individual and household knowledge, packaging, accessibility, and commercialization play major roles in herbal adoption. Yunus and Dida (2017) emphasized that the form in which herbal products are presented (be it fresh leaves, powders, capsules) can significantly affect their acceptance in urban areas. Efforts to develop user-friendly herbal formulations (e.g., tablets or tinctures) could make *A. paniculata* more accessible to broader demographics, particularly younger populations accustomed to modern health products.

Cultural preservation and biodiversity conservation are inextricably linked. Kampung Herbal Nginden stands as a promising model where both can be achieved simultaneously. This community herbal garden not only cultivates medicinal plants but also serves as an inspiring educational hub, fostering deep engagement with local biodiversity. Global cases such as those from Angola (Mawunu et al. 2024) and Papua (Fahmi et al. 2025) illustrate that safeguarding traditional plant knowledge through community empowerment and intellectual property protection enhances environmental stewardship and cultural continuity.

Finally, the integration of urban ethnomedicine into public health frameworks is not just essential but also reassuring. This includes recognizing traditional medicine in national health policies, funding local herbal initiatives, and promoting evidence-based use of medicinal plants. As WHO-Indonesia (2020) recommends, urban herbal practices should not be marginalized but seen as complementary tools in improving population health. Legal frameworks and interdisciplinary collaboration can elevate urban ethnobotany from informal knowledge to validated practices.

In conclusion, this study reveals a complex relationship between knowledge and the practical use of *A. paniculata* among residents of Kampung Herbal Nginden, highlighting the challenges and opportunities in sustaining urban ethnomedicine. Although more than half of the population expressed awareness of the health benefits of *sambiloto*, its practical application is hampered by taste, lack of knowledge about how to process it, and preferences for modern healthcare. This urban knowledge-practice gap reflects broader global patterns and suggests the need for targeted interventions such as formal herbal education, product innovation, and policy integration. Empowering women, institutionalizing community herbal programs, and protecting cultural knowledge through legal and educational mechanisms can bridge the divide between traditional and modernity. Ultimately, integrating ethnobotanical wisdom into urban health strategies will enhance biodiversity conservation, support public well-being, and preserve Indonesia's rich medicinal heritage.

This study has some limitations. The research was conducted in a single urban herbal village with a relatively small sample size, which may limit the generalizability of the findings. Additionally, data was collected during a specific season, which might have influenced plant availability and community engagement. While respondents shared information on the uses and perceived efficacy of *A. paniculata*, no laboratory validation of bioactivity was conducted in this study. Future research should consider broader geographic coverage, longer data collection periods, and biochemical validation to strengthen and contextualize the findings.

ACKNOWLEDGEMENTS

The authors would like to thank the residents of Kampung Herbal Nginden, Surabaya, Indonesia, for their warm participation and valuable contributions to this study. We are also grateful to the School of Environmental Science, Universitas Indonesia, Indonesia, for their support during data collection and analysis. Special appreciation goes to the local herbal practitioners and community leaders who shared their knowledge and insights.

REFERENCES

Afra DN, Iskandar Y. 2019. Review artikel: Aktivitas andrographolida dan senyawa turunannya dari tanaman sambiloto (*Andrographis paniculata*) sebagai antihiperlipidemia. Farmaka 17 (2): 118-123. DOI: 10.24198/jf.v17i2.23452. [Indonesian]

Akilandeswari G, Anand AV, Sampathkumar P, Moorthi PV, Preethi B. 2019. A prospective review on phyto-pharmacological aspects of *Andrographis paniculata*. Syst Rev Pharm 10 (1): 15-19. DOI: 10.5530/srp.2019.1.3.

Alkandahri MY, Subarnas A, Berbudi A. 2018. Aktivitas immunomodulator tanaman sambiloto (*Andrographis paniculata* Nees). Farmaka 16 (3): 16-20. DOI: 10.24198/jf.v16i3.14237. [Indonesian]

Ashaolu TJ. 2020. Immune boosting functional foods and their mechanisms: A critical evaluation of probiotics and prebiotics. Biomed Pharmacother 130: 110625. DOI: 10.1016/j.biopha.2020.110625.

Ayuningrum LS, Setyaningrum M, Agustin MR, Sabrina MA, Arifiani KN, Nazar IA, Md Naim D, Setyawan AD. 2024. Ethnobotanical study of homegarden by local communities in the urban area of Surakarta City, Central Java, Indonesia. Asian J Ethnobiol 7 (2): 79-88. DOI: 10.13057/asianjethnobiol/y070201.

Aziz MHA, Yusoff ANM, Magima MM. 2023. The use of herbs according to the perspective of traditional malay medicine in Selangor, Malaysia. Intl J Acad Res Bus Soc Sci 13 (18): 19933. DOI: 10.6007/IJARBSS/v13-i18/19933.

Babich O, Sukhikh S, Prosekov A, Asyakina L, Ivanova S. 2020. Medicinal plants strengthen immunity during a pandemic. Pharmaceuticals 13 (10): 313. DOI: 10.3390/ph13100313.

Chen SL, Yu H, Luo HM, Wu Q, Li CF, Steinmetz A. 2016. Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. Chin Med 11: 37. DOI: 10.1186/s13020-016-0108-7.

Cordero CS, Guillergan LR, Nievales MFJ, Alejandro GKD. 2025. Ethnobotanical study of medicinal plants used in an urban community in Iloilo City, Philippines. Biodiversitas 26 (5): 2167-2181. DOI: 10.13057/biodiv/d260515.

Dapar MLG, Alejandro GJD, Meve U, Liede-Schumann S. 2020. Quantitative ethnopharmacological documentation and molecular confirmation of medicinal plants used by the Manobo tribe of Agusan del Sur, Philippines. J Ethnobiol Ethnomed 16 (1): 14. DOI: 10.1186/s13002-020-00363-7.

Darmastuti SA, Nazar IA, Setyawan AD. 2024. Plant diversity and its use in Javanese urban home garden: An ethnobotanical study in Central Java, Indonesia. Asian J Ethnobiol 7 (1): 32-42. DOI: 10.13057/asianjethnobiol/y070104.

De Meyer E, Ceuterick M, Vanhove W, Heytens J, Mimbu JE, Van Damme P, de la Peña E. 2025. Medicinal plant use and diversity in the urban area of Idiofa, Democratic Republic of Congo. J Ethnobiol 45 (1): 38-50. DOI: 10.1177/02780771241303900.

Dutta T, Anand U, Saha SC, Mane AB, Prasanth DA, Kandimalla R, Prockow J, Dey A. 2021. Advancing urban ethnopharmacology: A modern concept of sustainability, conservation, and cross-cultural adaptations of medicinal plant lore in the urban environment. Conserv Physiol 9 (1): coab073. DOI: 10.1093/conphys/coab073.

Fahmi MS, Rado RH, Klau RG, Majid I. 2025. Preserving ethnobotany in Wasur National Park South Papua through intellectual property rights protection. IOP Conf Ser Earth Environ Sci 1471 (1): 012055. DOI: 10.1088/1755-1315/1471/1/012055.

Geng Y, Wang Y, Pei S. 2025. Urban ethnobotany: An emerging research field of ethnobotany. J Plant Resour Environ 34 (2): 1-10. DOI: 10.3969/j.issn.1674-7895.2025.02.01.

Ihemezie EJ, Nawrath M, Strauß L, Stringer LC, Dallimer M. 2021. The influence of human values on attitudes and behaviours towards forest conservation. J Environ Manag 292: 112857. DOI: 10.1016/j.jenvman.2021.112857.

Ilmi H, Pamungkas IR, Tumewu L, Hafid AF, Widyawaruyanti A. 2021. Analgesic and antipyretic activities of ethyl acetate fraction tablet of *Andrographis paniculata* in animal models. Evid Based Complement Alternat Med 2021: 8848797. DOI: 10.1155/2021/8848797.

Jiang M, Sheng F, Zhang Z, Ma X, Gao T, Fu C, Li P. 2021. *Andrographis paniculata* and its major constituent andrographolide as potential antiviral agents. J Ethnopharmacol 272: 113954. DOI: 10.1016/j.jep.2021.113954.

Jokar NK, Noorhosseini SA, Allahyari MS, Damalas CA. 2017. Consumers' acceptance of medicinal herbs: An application of the technology acceptance model (TAM). J Ethnopharmacol 207: 203-210. DOI: 10.1016/j.jep.2017.06.017.

Kumar S, Singh B, Bajpai V. 2021. *Andrographis paniculata* (Burm.f.) Nees: Traditional uses, phytochemistry, pharmacological properties and quality control/quality assurance. J Ethnopharmacol 275: 114054. DOI: 10.1016/j.jep.2021.114054.

Mawunu M, Malungo AD, Cuca AL, Luyeye L, Ndiku L, Ngbolua KTN. 2024. Medicinal plants traditionally used by the rural Kimalalu people in the municipality of Songo (Uíge province), Northern Angola. Nat Resour Hum Health 5 (1): 40-69. DOI: 10.53365/nrfhh/192950.

Mayer M, Zbinden M, Vogl CR, Ivemeyer S, Meier B, Amorena M, Maeschli A, Hamburger M, Walkenhorst M. 2017. Swiss ethnoveterinary knowledge on medicinal plants-a within-country comparison of Italian speaking regions with north-western German speaking regions. J Ethnobiol Ethnomed 13 (1): 1-18. DOI: 10.1186/s13002-016-0106-y.

Miller GT, Spoolman SE. 2016. Environmental Science (Fifteenth). Cengage Learning, Canada.

Miyamoto K, Ehara H, Thaman R, Veitayaki J, Yoshida T, Kobayashi H. 2021. Traditional knowledge of medicinal plants on Gau Island, Fiji: Differences between sixteen villages with unique characteristics of cultural value. J Ethnobiol Ethnomed 17 (1): 51. DOI: 10.1186/s13002-021-00481-w.

Novriyanti N, Nursanti N, Wulan C. 2021. Short communication: Do women have a piece of traditional knowledge of medicinal plants? A case study around Jambi Urban Forest, Indonesia. Asian J Ethnobiol 4 (2): 115-119. DOI: 10.13057/asianjethnobiol/y040206.

Pozdnyakova Y, Murzatayeva A, Omarova G. 2025. Assessing biodiversity, health benefits, and knowledge of wild edible plants in rural and urban areas. J Hum Earth Future 6 (1): 131-149. DOI: 10.28991/HEF-2025-06-01-09.

Radha P, Udhayavani C, Nagaraj R, Sivaranjani K. 2025. Medico-ethnobotanical survey of medicinal plants used in the treatment of skin diseases in Tiruppur District, Tamil Nadu, India. Phytomed Plus 5 (1): 100692. DOI: 10.1016/j.phyplu.2024.100692.

Safitri KI, Abdoellah OS, Gunawan B. 2021. Urban farming as women empowerment: Case study Sa'uyunan Sarijadi women's farmer group in Bandung City. E3s Web Conf 249: 1007. DOI: 10.1051/e3sconf/202124901007.

Sa-Ngiamsuntorn K, Suksatu A, Pewkliang Y, Thongsri P, Kanjanasirirat P, Manopwisedjaroen S, Charoensutthivarakul S, Wongtrakoongate P, Pitiporn S, Chaopreecha J, Kongsomros S, Jearawuttanakul K, Wannalo W, Khemawoot P, Chutipongtanate S, Borwornpinyo S, Thitithanyanont A, Hongeng S. 2020. Anti-SARS-CoV-2 activity of *Andrographis paniculata* extract and its major component andrographolide in human lung epithelial cells and cytotoxicity evaluation. J Nat Prod 84 (4): 1261-1270. DOI: 10.1021/acs.jnatprod.0c01324.

Santhyami, Laraswati, Agustina L, Agustina P. 2024. Exploring urban ethnobotany: A case study of medicinal plants traded in Gede Hardjonagoro Market, Surakarta, Indonesia. Trop J Nat Prod Res 8 (4): 6839-6851. DOI: 10.26538/tjnpr/v8i4.13.

Ullah I, Akhtar S, Adnan M, Nawab J, Ullah S, Abdullah-Al-Wadud M. 2025. Ethnobotanical knowledge and ethnomedicinal uses of plant resources by urban communities of Khyber Pakhtunkhwa, Pakistan: A novel urban ethnobotanical approach. J Ethnobiol Ethnomed 21: 13. DOI: 10.1186/s13002-025-00766-4.

WHO-Indonesia. 2020. Traditional Medicine and Integrative Health Survey 2020. WHO Country Office for Indonesia, Jakarta.

Wibowo A, Setyawati A, Masyithoh G, Rahayu ES. 2021. Local wisdom in the preservation and diversification of medicinal plant use (A case study of the Lawu mountainside community on the island of Java, Indonesia). IOP Conf Ser Earth Environ Sci 905: 012025. DOI: 10.1088/1755-1315/905/1/012025.

Yeganeh H, Farsi R, Frozeh MR, Pournemati A, Mirdeilami SZ. 2022. A study of variables affecting the consumption of medicinal plant products in urban communities, north of Iran. Environ Dev Sustain 24 (5): 7455-7469. DOI: 10.1007/s10668-021-01698-1.

Yunus M, Dida S. 2017. Packaging of herbal medicine and its connection to the acceptance rate of the urban population viewed from a biological, agricultural, economic, business and communication perspective. Online J Biol Sci 17 (4): 285-289. DOI: 10.3844/ojbsci.2017.285.289.