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ETHNOBOTANICAL INSIGHTS INTO PLANT DIVERSITY ALONG THE ECOTOURISM CORRIDOR OF MOUNT PRAU IN PURWOSARI VILLAGE, INDONESIA

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ABSTRACT

Examining ethnobotany in mountainous regions established as popular hiking destinations is essential for conservation initiatives. In this study, we aim to explore the ethnobotanical knowledge of the indigenous communities and to analyze the plant diversity in the ecotourism corridor to Mount Prau in Purwosari Village, Central Java, Indonesia. Ethnobotanical data was collected through semi-structured interviews with informants recruited via purposive sampling. An exploratory approach was used to inventory plant diversity along the ecotourism corridor of Mount Prau in Purwosari village. Our key informants comprised village officials, community leaders, Mount Prau caretakers, and basecamp managers. The findings indicated that the informants explained a total of 68 plant species, which were utilized by the community for various purposes. These plants served as valuable food sources, medicinal ingredients, and economic value, and they were also used for fodder, building materials, shade, and conservation purposes. In the ecotourism corridor in Purwosari village, which serves as the conservation trail for Mount Prau, a total of 117 plant species were identified through an inventory in this study. Finding some invasive alien plant species, such as Acacia decurens and Clidemia hirta, and an endangered species, Castanopsis argentea, highlights the importance of conservation efforts for protecting and preserving the diverse plant species found along the conservation trail to Mount Prau.

Keywords: conservation trail, ecotourism corridor, ethnobotany, hiking trail, mount prau

INTRODUCTION

Hiking in mountainous areas is an increasingly sought-after form of nature-based tourism and ecotourism. For hiking enthusiasts, a country with numerous mountains offers the allure of mountain peaks, biodiversity within mountainous forests, and captivating geological sites along hiking trails (Chakrabarty & Sadhukhan, 2018) . The variety of flora and fauna found on these hikes adds to the appeal for nature lovers who seek unique experiences while exploring different ecoregions (Margalida, 2017).

In Indonesia, visiting mountain areas, such as hiking or climbing, has become a popular tourism activity that is experiencing growing demand. In 2018, approximately 170,000 tourists climbed four renowned mountains in Central Java: Mount Andong, Mount Prau, Mount Merbabu, and Mount Slamet (Sabila & Purwanti, 2020). However, this trend has shifted from primarily focused on sports to ecotourism and now towards nature-based tourism. The move toward ecotourism reflects a growing interest in exploring the natural environment and local cultures (Hamidi et al., 2023). This shift highlights the transition from mere sports to more sustainable forms of tourism that emphasize the conservation of natural resources and cultural heritage while contributing to increased mass tourism due to rising awareness of these unique experiences.

Mass tourism and the increasing preferen-

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ce for mountaineering have been associated with various negative impacts on the environment and biodiversity (Asmin, 2018). Studies have shown that these activities can lead to climber litter, destruction of vegetation, extraction of rare plants, soil erosion, and habitat destruction for wildlife (Canteiro et al., 2018). The development of mountain climbing as a form of mass tourism has degraded the environment, biodiversity, and habitats (Apollo & Andreychouk, 2020; Jones et al., 2021; Latip et al., 2020; Mehdi Sadeghian, 2019; Peęksa & Ciach, 2015; Pereira et al., 2022; Popov et al., 2024; Świgost, 2015). Addressing these impacts is crucial to preserving these mountainous regions' natural resources and cultural heritage.

Hence, conducting a comprehensive mapping of the biodiversity and natural resources in mountainous forest areas is imperative to facilitate in-depth research. Furthermore, there is a need for further investigation into the social aspects associated with the knowledge and utilization of natural resources by the residents living around the slopes of the mountains. This involves delving into studies on local wisdom and community knowledge related to the potential of biology and the environment, also known as ethnobiology (Purwanto, 2021). The initial steps in planning and managing mountainous forest areas as ecotourism destinations involve assessing their potential (Bhatta & Chan, 2023; Samani et al., 2023). This can be achieved through ethnobotanical studies on using various plant species by the local communities.

As a scientific study, Ethnobotany focuses on understanding the interaction between humans and plants in everyday life, passed down between generations (Hakim., 2014). This includes assessing traditional botanical knowledge, quantitatively measuring the use and management of botanical resources, evaluating the benefits obtained from plants, and identifying projects that enhance the value local communities derive from ecological knowledge and resources.

Similar studies include research on the knowledge of the people in some mountainous regions, but the relationship between community knowledge and the use of plants in mountain climbing as an ecotourism activity has not been extensively discussed (Kuspraningrum et al., 2020; Putri et al., 2017; Rahayu et al., 2021; Ramadhan et al., 2017; Utami et al., 2019). This knowledge is crucial for identifying the types of plants that the local community and hikers can use as food or medicine for survival in nature.

In mountainous regions, ethnobotanical studies are crucial in documenting traditional plant uses and their impact on biodiversity conservation. The correlation between ethnobotany and conservation is evident in the traditional practices of Indigenous communities. Knowledge of plant species, their uses, and their cultural significance offers valuable insights for conservation strategies (Luo et al., 2024; Rahayuningsih et al., 2017). Understanding the local communities' dependence on natural resources provides a foundation for designing sustainable management plans that benefit both the people and the environment.

The connection between traditional plant uses and conservation efforts is pivotal for ensuring the sustainability of these natural resources (Brondízio et al., 2021; Chen et al., 2016; Uslan et al., 2024). These communities' conventional uses of plants provide valuable resources for food, medicine, and economic value and contribute to the area's cultural and traditional practices (Rodrigues et al., 2022; Ulian et al., 2017). This intertwining of cultural significance and ecological importance highlights the need to understand and preserve ethnobotanical knowledge in the context of conservation efforts.

Indigenous communities' traditional practices and beliefs about utilizing plant species are invaluable for preserving biodiversity along hiking trails. Ethnobotanical knowledge enriches hikers' experiences by providing insights into the traditional uses of plants, including their uses for food, medicine, and cultural practices. This knowledge enhances the ecotourism experience and encourages the sustainable management of natural resources.

As ecotourism continues to gain popularity, it becomes increasingly important to recognize the link between indigenous knowledge of plant conservation and hiking activities. The conservation practices grounded in local traditions play a significant role in preserving the diversity of plant species along hiking trails. Integrating traditional knowledge into ecotourism activities helps cultivate a deeper appreciation for the natural environment among visitors and promotes the protection of these ecosystems. The interpretation of biological resources is vital in giving significance to ecotourism activities (Boley & Green, 2016; Chakraborty, 2019; Hakim, 2017), making research in this area essential.

The interpretation of biological resources, especially in plant conservation, plays a crucial role in education and preservation efforts. By interpreting the biological resources, ecotourism guides and conservationists can effectively

communicate the value and importance of these resources to hikers and other visitors. This includes explaining the ecological roles of various plant species, their traditional uses, and the threats they face from human activities and invasive species.

Effective interpretation enables visitors to gain a deeper understanding of the ecosystems they explore, fostering a sense of stewardship and responsibility toward the environment (Juma & Rohman, 2019; Kim et al., 2018). This educational component of ecotourism enriches the visitor experience and promotes conservation efforts by raising awareness about preserving biodiversity.

Mount Prau is one of the popular tourist destinations in Indonesia. It is located at coordinates 7°11′13″S - 109°55′22″E and spans multiple regencies, including Batang, Kendal, Temanggung, Wonosobo, and Banjarnegara within Central Java province. The peak in the Dieng Plateau reaches 2,565 meters above sea level. Near the summit, vast meadows serve as popular campsites for sunrise viewing, accommodating hundreds to thousands of hikers.

As an ecotourism site, Mount Prau can be accessed through several officially designated trails, including Wates, Patak Banteng, Kalilembu, Igirmranak, Dwarawati, Dieng, Pranten, and Ngelak. These routes generally pass through residential areas, agricultural lands, and forest regions. In addition, there are traditional hiking trails in the villages around Mount Prau's slopes, which are still largely forested (Alimah et al., 2021). There is an escalating apprehension regarding establishing new trails by local communities around Mount Prau, which, if not guided by the rigorous application of ecotourism principles, poses an augmented risk to the region's biodiversity and natural habitats.

One of the villages renowned for its traditional hiking route to Mount Prau is the village of Purwosari in Kendal Regency. The management of the hiking basecamp and the local community have designated this route as a limited ecotourism path with stricter hiking regulations. Consequently, the trail remains in a natural state with extensive forest cover. This hiking tourist corridor, known as "conservation trail," represents a trail dedicated to environmental conservation through responsible travel behavior while passing the route.

Our main aims in this study were to explore the ethnobotanical knowledge of indigenous communities and assess the plant diversity along the ecotourism corridor leading to Mount Prau in Purwosari Village, Central Java, Indonesia.

METHODS

The study was conducted in Purwosari village, Sukorejo sub-district, Kendal district, Central Java province, Indonesia (Figure 1). The ethnobotanical data collection methods involved conducting direct interviews guided by a set of key questions that included inquiring about the local names of plants, the parts of the plants used, their benefits, and how they were used. Semi-structured interviews were conducted by purposive sampling, where informants were selected based on their status and role in the community. The informants included basecamp managers, community leaders, village officials, and residents living around the basecamp.

The exploration approach was used to survey plant community species in Mount Prau›s hiking trail corridor via the Purwosari village conservation route. Data collection on plant species was executed along the entire trail, commencing at the hikers› base camp and concluding near the summit in the savanna area. After the inventory, plants were identified by using plant taxonomy books (Soepadmo & van Steenis, 1972; van Steenis, 1972; Backer and Bakhuizen van den Brink, 1968) and through the plant taxonomic website (POWO, 2024; BGCI, 2024) to ensure the scientific names. This approach was employed to comprehensively document the plant diversity along the ecotourism corridor leading to Mount Prau.

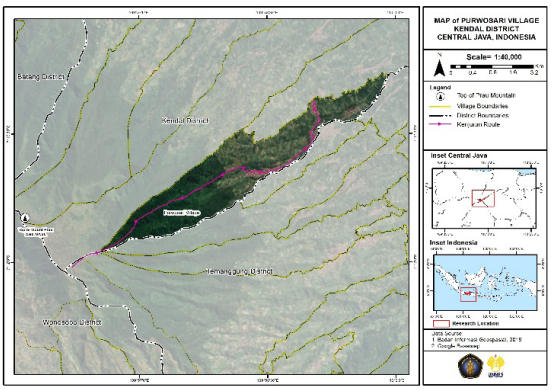

Figure 1. Research location in Purwosari Village, Kendal Regency, Central Java Province, Indonesia

Based on the interview results, the ethnobiological index values (Cultural Index, Relative Importance Index, and Cultural Value for Ethnospecies Index) were computed. These values offer a comprehensive understanding of the local community›s knowledge and traditional uses of plant species, providing valuable insights

into biodiversity conservation and managing natural resources. The data was processed and analyzed using the EthnobotanyR package (Whitney, 2019) In the R statistics program to obtain ethnobotanical index values..

RESULTS AND DISCUSSION

Our study interviewed 12 key respondents, including four village officials, three community leaders, and five basecamp managers. From these interviews, we documented a total of 68 plant species that are recognized and utilized by the local community. The proportion of information on the number of plant species and their uses obtained from each informant is visualized in Figure 2. This chord diagram shows informant01 provided the most comprehensive information about using plants around the climbing base camp. Informant01 is a Mount Prau caretaker and the basecamp management coordinator in Kenjuran, Purwosari village. He revealed details about 38 plant species, constituting 32.5% of the existing plants. Subsequently, two community leaders, specifically an elder informant05 and an ornamental plant collector informant10, contributed 17% and 16%, respectively. The remaining informants shared between 3% and 8% of the total plants identified in this study.

The chord diagram (Figure 2) effectively demonstrates the wealth and variety of ethnobotanical knowledge in Purwosari village, presenting detailed insights into the contributions of different informants to our understanding of plant species and their uses. The visualization emphasizes the significance of food and medicinal plants in the local community while also indicating notable, albeit more specialized, inputs to ornamental, economic, and conservation-related uses. This data underscores the importance of involving multiple informants to understand ethnobotanical practices comprehensively.

The interview findings indicated that the plants most commonly known and utilized by the community were categorized as plants for medicinal and food purposes, as depicted in Table 1. Following these were plants valued for their economic significance, such as a source of income, and ornamental plants. In contrast, there was minimal mention of plants serving as road shade, animal feed, conservation, and firewood. Notably, the informants highlighted specific plants associated with conservation among the caretakers and collectors of ornamental plants. Remarkably, bamboo and banyan trees were identified for their role in conserving water in the mountainous regions. It was observed that the caretaker of Mount Prahu had strategically planted bamboo to act as a barrier between the forested area and the agricultural land of the residents.

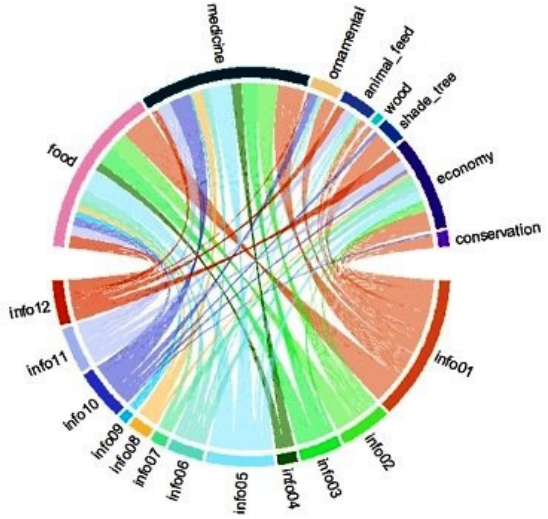

Figure 2. The number of plant species (lines number connected "info" and use categories) and their respective applications ("food," "medicine', "ornamental," "animal_feed," "wood," "economy," "shade_tree,' and "conservation") as provided by individual informants ("info01 – "info12"). The line color indicates information from each informant.

The table based on ethnobotanical interviews summarises the distribution of plant species utilized for various purposes in Purwosari village, Indonesia. The highest proportion of plant species (30.5%) is used for medicinal purposes, emphasizing traditional medicine's significant role in treating illnesses and maintaining general health in the local community. Food-related uses constitute the second largest category (23.8%), highlighting the importance of plants in the local diet for both daily and occasional use. Economic uses account for 13.3% of the plant species, reflecting their role in supporting the local economy through sales and income generation. Additionally, ornamental uses make up 8.6%, indicating the cultural or aesthetic value placed on these species. This data provides a comprehensive overview of the village's diverse uses of plant species, emphasizing the close relationship between the community and the plant resources.

In the research conducted, distinct categories of plant usage were identified, each serving a vital purpose within the community. Noteworthy categories include shade trees and animal feed, representing an equal proportion of plant species

Table 1. The proportion of the number of plants in each category of use from the results of interviews

Category	Description	Plant (%)
Medicine	medical uses for illness and general health	30.5
Food	food, drinking, occasional and casual food	23.8
Economy	economic use, sales, income generation	13.3
Ornamental	ornamental, for decorative or attractive	8.6
Shade tree	shade and shelter from wind and sun	7.6
Animal feed	animal feed, generally for goat and cow	7.6
Conservation	conservation purposes, e.g., for land and water	5.7
Wood	firewood for cooking	2.9

at 7.6%. These categories highlight the importance of providing shelter and feeding livestock, which is essential for agriculture and animal husbandry in the village. There is also a focus on conservation purposes, accounting for 5.7%, reflecting the community's conscientious efforts to preserve land and water resources. Moreover, wood use, primarily for firewood, is the smallest category at 2.9%, implying efficient use or reliance on other energy sources for cooking. These findings underscore the multifaceted role of plant species in supporting various aspects of life and livelihood in Purwosari village.

The chord diagram (Figure 3) illustrates various plant uses within the local community. Traditional medicine is prominently connected to multiple plant species, showing its significance in local ethnobotanical knowledge. Similarly, the food category exhibits substantial connections, underscoring the importance of plants in local dietary practices. Moreover, the economic uses of plants are also notable, with various species linked to income-generating activities, reflecting the financial value derived from these plants.

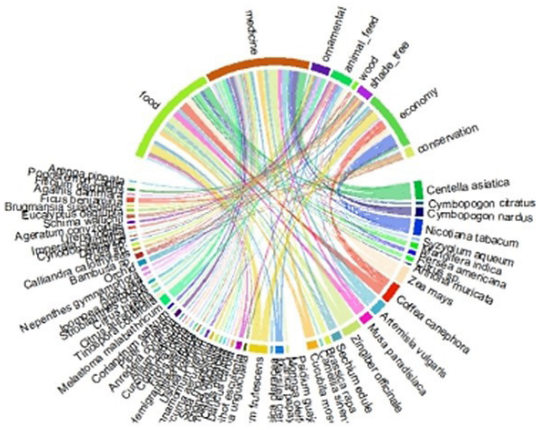

Figure 3. The proportion of plant species and their use Categories. The line color indicates information on each plant species.

The diagram also highlights the significance of ornamental, animal feed, and shade tree uses, demonstrating plants' diverse roles in the community. Additionally, conservation purposes, while fewer in number, are crucial for sustainable practices and environmental preservation. It is evident from the diagram that the wood category, primarily for firewood, is the least connected, suggesting limited use of plants for cooking fuel. Overall, the diagram showcases the rich ethnobotanical knowledge and the integral role plants play in the cultural, economic, and environmental aspects of Purwosari village.

The bar chart in Figure 4 illustrates the ethnobotanical significance of ten plant species that get the highest score based on the three ethnobotanical indices. Nicotiana tabacum, Coffea canephora, and Centella asiatica exhibit the highest Cultural Index (CI) values, suggesting these plants have significant cultural importance within the community. Similarly, these species also show high Relative Importance Index (RI) values, indicating their overall relevance in various aspects such as medicinal, food, and economic uses. Zingiber officinale and Capsicum frutescens also display notable CI and RIs values, reflecting their multifaceted utility and cultural significance.

The Cultural Value for Ethnoscience (CVe) index values, represented by grey bars, are generally lower across all species than CI and RIs values. However, they still provide insight into the knowledge and traditional practices associated with these plants. For instance, Zea mays and Artemisia vulgaris, while showing moderate CI and RIs values, have relatively low CVe values, suggesting a need for further documentation and preservation of ethnobotanical knowledge related to these species. Overall, the chart underscores the prominent role of specific plants in the cultural and practical life of Purwosari village, highlighting the importance of maintaining ethnobotanical knowledge for future generations.

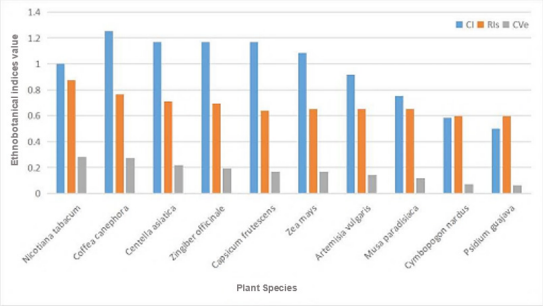

Figure 4. The Cultural Index (CI), Relative Importance Index (Ris), and Cultural Value for Ethnoscience (CVe) indices for the ten plant species most commonly cited by informants.

The survey of plant species in the ecotourism corridor of Mount Prau along the conservation path in Purwosari village identified 117 different species of plants belonging to 61 families. The Orchidaceae and Asteraceae families have the most members found, with 12 and 9 species, respectively. Based on a review of the literature on invasive plant identification (Lowe et al., 2008; PerMen LHK (Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia), 2016; Setyawati et al., 2015; Tjitrosoedirdjo. et al., 2016) , it is clear that certain plant species (18 species) found along the Mount Prau hiking trail via Purwosari are non-native and have the potential to become invasive (Table 2). The invasive plant species discovered along the Mount Prau hiking trail originate from various plant families, with Asteraceae being the most prevalent. This suggests that members of the Asteraceae family have a high adaptive capacity and are more prone to becoming invasive in this ecosystem. The table also demonstrates diverse growth habits among the invasive plants, including herbs, shrubs, and trees. Dominant herb species such as Centella asiatica and Imperata cylindrica are abundant on this list. Additionally, common shrubs like Austroeupatorium inulifolium and Clidemia hirta, as well as tree species like Acacia decurrens and Cinchona pubescens, indicate that invasion occurs not only in lower vegetation but also in higher strata.

Exploration in the ecotourism corridor of Mount Prau via Purwosari also revealed the presence of an endangered and protected plant species, Castanopsis argentea. This particular plant was identified as a solitary individual along the hiking trail, highlighting its vulnerable status. Its discovery underscores the importance of conservation efforts in preserving the biodiversity of this area. The ethnobotanical data and plant diversity in the Mount Prau ecotourism corridor of Purwosari village represent a valuable source of information about the interactions between local communities and plant resources. The findings from the survey of plant species along the conser-

Table 2. List of potentially invasive alien plant species found on the Mount Prau hiking trail via Purwosari

Species Name	Family	Habitus
Centella asiatica	Apiaceae	Herb
Eryngium foetidum	Apiaceae	Shrub
Ageratina riparia	Asteraceae	Herb
Austroeupatorium inulifolium	Asteraceae	Shrub
Bidens pilosa	Asteraceae	Herb
Crassocephalum crepidiodes	Asteraceae	Herb
Eupatorium odoratum	Asteraceae	Shrub
Sphagneticola trilobata	Asteraceae	Herb
Tithonia diversifolia	Asteraceae	Shrub
Acacia decurens	Fabaceae	Tree
Calliandra calothyrsus	Fabaceae	Shrub
Clidemia hirta	Melastomataceae	Shrub
Melastoma malabathricum	Melastomataceae	Shrub
Imperata cylindrica	Poaceae	Herb
Cinchona pubescens	Rubiaceae	Tree
Brugmansia suaveolens	Solanaceae	Shrub
Lantana camara	Verbenaceae	Shrub
Stachytarpheta urticifolia	Verbenaceae	Herb

(Data sources: resulted from primary data analysis, 2023)

vation path provide insights into the diverse uses of plants and emphasize the significance of traditional knowledge in leveraging plant resources for various purposes. This discussion delves deeper into the ethnobotanical data and plant diversity, shedding light on their implications for ecological conservation, cultural practices, and sustainable livelihoods in the region. (Arangote, 2018; Mao et al., 2019).

The documented uses of plant species in the Mount Prau ecotourism corridor underscore plants' multifaceted roles in supporting the local community's daily life and livelihoods. With medicinal, food-related, economic, and ornamental uses constituting a significant proportion of plant species, traditional knowledge plays a crucial role in harnessing the potential of plant resources. (Biró et al., 2014). The high proportion of plant species used for medicinal purposes reflects the reliance on traditional medicine for healthcare, highlighting the community's deep-rooted knowledge of medicinal plants and their therapeutic properties. Similarly, the utilization of plants for food, economic purposes, and ornamental value underscores the diverse ways in which plants contribute to the cultural and economic fabric of the village.

The presence of invasive plant species along the Mount Prau hiking trail raises concerns about the potential ecological impacts of these plants on the native vegetation and ecosystem dynamics. Identifying alien invasive plant species, particularly those belonging to families with high adaptive capacity (Dalle Fratte et al., 2019; Oduor et al., 2016; Zhou et al., 2022), calls for targeted management strategies to mitigate their spread and protect the ecological integrity of the corridor. Additionally, the discovery of a rare and protected plant species, Castanopsis argentea, underscores the need for conservation efforts to safeguard the biodiversity and habitat of such vulnerable species within the ecotourism corridor.

Engaging local communities in the conservation and sustainable utilization of plant resources is essential for promoting effective stewardship of the ecotourism corridor(Adom et al., 2020; Imanishimwe, 2022). The rich ethnobotanical knowledge embedded within the community serves as a reservoir of traditional practices, cultural significance, and ecological insights related to plant diversity. (Das et al., 2021). Efforts to acknowledge and document traditional knowledge are pivotal in preserving and transmitting valuable ethnobotanical information across generations. This can effectively support the conservation of plant diversity and the continuation of indigenous practices.

Documenting traditional knowledge related to plant uses, cultivation methods, and the cultural significance of specific plant species can provide a comprehensive understanding of the intricate relationship between local communities and their natural surroundings (Aswani et al., 2018; Bennett, 2016; Clark et al., 2016; Dodds et al., 2018). This documentation can also serve as a foundation for developing sustainable conservation and management strategies that align with the community's needs and practices, ultimately promoting the preservation of plant diversity and safeguarding traditional knowledge for future generations.

The relationship between indigenous knowledge and plant conservation in the ecotourism corridor of Mount Prau is a pivotal aspect of preserving the area's biodiversity. The ethnobotanical data collected from local communities showcase the intricate connection between traditional practices and the utilization of plant resources. The presence of diverse uses for medicinal, food-related, economic, and ornamental purposes underscores plants' multifaceted roles in supporting the local community's daily life and livelihoods. This highlights the importance of indigenous knowledge in leveraging plant resources for various purposes, emphasizing the need to integrate traditional practices into conservation efforts to ensure the sustainable utilization of plant diversity.

Furthermore, discovering invasive and rare plant species within the ecotourism corridor emphasizes the significance of engaging local communities in conservation initiatives. Identifying invasive plant species, particularly those with high adaptive capacity, calls for targeted management strategies to mitigate their spread and protect the area's ecological integrity. Additionally, a rare and protected plant species underscores the necessity for conservation efforts to safeguard the biodiversity and habitat of vulnerable species within the corridor. Integrating indigenous knowledge into conservation practices can promote effective stewardship of the ecotourism corridor, ensuring the continuation of traditional practices and preserving valuable ethnobotanical information for future generations (Adom et al., 2020; Suvanto, 2020; Swamy et al., 2018). This underscores the importance of documenting traditional knowledge related to plant uses and cultural significance to develop sustainable management strategies that align with the needs and practices of the community, ultimately promoting the conservation of plant diversity.

CONCLUSION

The ethnobotanical data and plant diversity documented in the Mount Prau ecotourism corridor of Purwosari village showcase the rich cultural significance of plant resources and emphasize the need for conservation and sustainable practices. The multifaceted uses of plant species underscore the intricate relationship between local communities and their natural environment, highlighting the importance of traditional knowledge in promoting ecological conservation and sustainable livelihoods. Furthermore, identifying invasive plant species and discovering rare and protected plants call for concerted efforts to preserve the biodiversity and environmental balance of the ecotourism corridor.

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REFERENCES

Adom, D., Sawicka., B., Umachandran., K., & Ziarati., P. (2020). Efficient Approaches in Ensuring the Active Involvement of Local People in Biodiversity Conservation Projects. *International Journal of Basic & Applied Sciences*, *20*(2), 17–31.

Alimah, S., Mujabah, I. S., Abdullah, M., Hadiyanti, L. N., & Mubarok, I. (2021). Species Richness of spermatophytes in Mranak forest area of mount Prau, Central Java, Indonesia. *Journal of Physics: Conference Series*, *1918*(5).

Apollo, M., & Andreychouk, V. (2020). Mountaineering and the natural environment in developing countries : an insight to a comprehensive approach. *International Journal of Environmental Studies*, *77*(6), 942–953.

Arangote, E. (2018). Implication to Environmental Education of Indigenous Knowledge and the Ecosystem of Upland Farmers in Aklan, Philippines. *IOP Conference Series: Earth and Environmental Science*, *167*(1).

Asmin, F. (2018). Ekowisata Dan Pembangunan Berkelanjutan: Dimulai Dari Konsep Sederhana. In *Yogyakarta*. Deepublish.

Aswani, S., Lemahieu, A., & Sauer, W. H. H. (2018). Global trends of local ecological knowledge and future implications. *PLoS ONE*, *13*(4), 1–19.

Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, *30*(3), 582–592.

Bhatta, K. D., & Roger C.K Chan. (2023). Ecotourism, Environmental Impacts and Sustainability in the Himalayan Settlements: Study of Sagarmatha (Mt. Everest) National Park, Nepal. *Himalayan Journal of Applied Science and Engineering*, *4*(1), 15–31.

Biró, É., Babai, D., Bódis, J., & Molnár, Z. (2014). Lack of knowledge or loss of knowledge? Traditional ecological knowledge of population dynamics of threatened plant species in East-Central Europe. *Journal for Nature Conservation*, *22*(4), 318–325.

Boley, B. B., & Green, G. T. (2016). Ecotourism and natural resource conservation: The potential for a sustainable symbiotic relationship. *Journal of Ecotourism*, *15*(1), 36–50.

Brondízio, E. S., Aumeeruddy-Thomas, Y., Bates, P., Carino, J., Fernández-Llamazares, Á., Ferrari, M. F., Galvin, K., Reyes-García, V., McElwee, P., Molnár, Z., Samakov, A., & Shrestha, U. B. (2021). Locally Based, Regionally Manifested, and Globally Relevant: Indigenous and Local Knowledge, Values, and Practices for Nature. *Annual Review of Environment and Resources*, *46*, 481–509.

Canteiro, M., Córdova-Tapia, F., & Brazeiro, A. (2018). Tourism impact assessment: A tool to evaluate the environmental impacts of touristic activities in Natural Protected Areas. *Tourism Management Perspectives*, *28*, 220–227.

Chakrabarty, P., & Sadhukhan, S. K. (2018). *Trekking and Geotourism: A Symbiosis In Case Of Goeche La Trek Route Of West Sikkim In India*. *23*(3).

Chakraborty, A. (2019). Does nature matter? Arguing for a biophysical turn in the ecotourism narrative. *Journal of Ecotourism*, *18*(3), 243–260.

Chen, S. L., Yu, H., Luo, H. M., Wu, Q., Li, C. F., & Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *Chinese Medicine (United Kingdom)*, *11*(1), 1–10.

Clark, W. C., Van Kerkhoff, L., Lebel, L., & Gallopin, G. C. (2016). Crafting usable knowledge for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(17), 4570–4578.

Dalle Fratte, M., Bolpagni, R., Brusa, G., Caccianiga, M., Pierce, S., Zanzottera, M., & Cerabolini, B. E. L. (2019). Alien plant species invade by occupying similar functional spaces to native species. *Flora: Morphology, Distribution, Functional Ecology of Plants*, *257*(June), 151419.

Das, B. D., Paudel, N., Paudel, M., Khadka, M. K., Dhakal, S., & Amrit, K. C. (2021). Ethnobotanical knowledge of kewrat community of morang district, eastern Nepal. *Ethnobotany Re-*

search and Applications, *21*, 1–11.

Dodds, R., Ali, A., & Galaski, K. (2018). Mobilizing knowledge: determining key elements for success and pitfalls in developing community-based tourism. *Current Issues in Tourism*, *21*(13), 1547–1568.

Hakim., L. (2014). *Etnobotani dan Manajemen Kebun-Pekarangan Rumah: Etnobotani dan Manajemen Kebun-Pekarangan Rumah: Ketahanan Pangan, Kesehatan dan Agrowisata*. https://biologi.ub.ac.id/wp-content/uploads/2015/11/ETNOBOTANI-dan-MANAJEMEN-KEBUN-PEKARANGAN-RUMAH.pdf

Hakim, L. (2017). Managing biodiversity for a competitive ecotourism industry in tropical developing countries: New opportunities in biological fields. *AIP Conference Proceedings*, *1908*.

Hamidi, H., Purwoko, A. A., Al Idrus, A., Harjono, A., Rokhmat, J., & Sukarso, A. A. (2023). Trends in Ecotourism Research in Indonesia: Basic Analysis of the Development of Ecotourism-Based Teaching Materials. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 246–255.

Imanishimwe, A. (2022). *The linkages between Biodiversity Conservation, Ecosystem Ser-vices, and Community Development in Tropical Region: A Review*. *1*(3). https://primerascientific.com/psenhttps://primerascientific.com/psen

Jones, T. E., Apollo, M., & Bui, H. T. (2021). Mountainous Protected Areas & Nature-Based Tourism in Asia. *Geographies of Tourism and Global Change*, 3–25.

Juma, Y., & Rohman, F. (2019). *Persepsi dan Apresiasi Masyarakat Suku Tengger terhadap Biodiversitas Tumbuhan Obat di Sekitar Kawasan Taman Nasional Bromo Tengger Semeru*. *1*(1), 1–7.

Kim, M. J., Park, J. Y., Reisinger, Y., & Lee, C.-K. (2018). Predicting responsible tourist behavior: Exploring pro-social behavior and perceptions of responsible tourism. *International Journal of Tourism and Hospitality Research*, *32*(4), 5–20.

Kuspraningrum, E., Luth, T., Yuliati, Safa'at, R., & Kuspradini, H. (2020). Review: The conservation of tengger indigenous people's traditional knowledge of biological natural resource-based disease treatments. *Biodiversitas*, *21*(11), 5040–5053.

LaRochelle, S., & Berkes, F. (2003). Traditional Ecological Knowledge and Practice for Edible Wild Plants: Biodiversity Use by the Rarámuri, in the Sirerra Tarahumara, Mexico. *International Journal of Sustainable Development and World Ecology*, *10*(4), 361–375.

Latip, N. A., Jaafar, M., Marzuki, A., Roufechaei, K. M., Umar, M. U., & Karim, R. (2020). The impact of tourism activities on the environment of Mount Kinabalu, unesco world heritage site. *Planning Malaysia*, *18*(4), 399–413.

Lowe, S., Browne, M., & Boudjelas, S. (2008). *100 of the World ' S Worst Invasive Alien Species*. *12*(3), 12. http://interface.creative.auckland.ac.nz/database/species/reference_files/100English.pdf

Luo, B., Tong, Y., Liu, Y., Zhang, Y., Qin, Y., & Hu, R. (2024). Ethnobotanical insights into the traditional food plants of the Baiku Yao community: a study of cultural significance, utilization, and conservation. *Journal of Ethnobiology and Ethnomedicine*, *20*(1).

Mao, S., Shen, Y., Deng, H., & Wu, G. (2019). Distribution pattern of traditional ecological knowledge on plant utilization among major minority peoples in Guizhou, China. *International Journal of Sustainable Development and World Ecology*, *26*(1), 37–44.

Margalida, A. (2017). Importance of Long-Term Studies to Conservation Practice: The Case of the Bearded Vulture in the Pyrenees. In *Advances in Global Change Research* (Vol. 62).

Mehdi Sadeghian, M. (2019). Negative Environmental Impacts Of Tourism. *Journal of Novel Applied Sciences*, *8*(3), 71–76. http://www.theworldcounts.com/counters/impact_of_transport_on_environment/negative_environmental_impacts_of_tourism

Oduor, A. M. O., Leimu, R., & van Kleunen, M. (2016). Invasive plant species are locally adapted just as frequently and at least as strongly as native plant species. *Journal of Ecology*, *104*(4), 957–968.

Peęksa, Ł., & Ciach, M. (2015). Negative effects of mass tourism on high mountain fauna: The case of the Tatra chamois Rupicapra rupicapra tatrica. *Oryx*, *49*(3), 500–505.

Pereira, P., Inacio, M., Bogunovic, I., Francos, M., Barceló, D., & Zhao, W. (2022). Ecosystem Services in Mountain Environments: Benefits and Threats. *Pirineos*, *177*.

PerMen LHK (Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia). (2016). Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.14 2016 tentang Jenis Invasif. *Menteri Lingkungan Hidup Dan Kehutanan Republik Indonesia*, 1–23.

Popov, I., Moiseev, A., Iurmanov, A., Romanov, A., Karpov, E., Orlova, K., Tereshchenko, N., Emets, E., Lebedev, Y., & Gnedenko, A. (2024). Impact of Tourism on Pristine Habitats At the Avachinsky Pass (Kamchatka), a World Heritage Site. *Geography, Environment, Sustainability*, *17*(2), 18–25.

Purwanto, Y. (2021). Applying Ethnobiology in Sustainable Management and Utilization of Biological Resources in Indonesia. *EPiC Series in Biological Sciences*, *1*, 8--9.

Putri, W. K., Hakim, L., & Indriyani, S. (2017). Plants Diversity for Ethnic Food and the Potentiality of Ethno-culinary Tourism Development in Kemiren Village, Banyuwangi, Indonesia. *Journal of Indonesian Tourism and Development Studies*, *5*(3), 161–168.

Rahayu, M., Keim, A. P., Nikmatullah, M., Rustiami, H., Susan, D., & Sujarwo, W. (2021). The ethnoecology of sasak people in mandalika, lom-

bok island: Local knowledge and wisdom in relation with land use. *Jurnal Pendidikan IPA Indonesia*, *10*(3), 407–415.

Rahayuningsih, M., Utami, N. R., & Abdullah, M. (2017). Developing local wisdom to integrate ethnobiology and biodiversity conservation in Mount Ungaran, Central Java Indonesia. *International Journal of Environmental and Ecological Engineering*, *4*(9), 1.

Ramadhan, S. F., Metusala, D., & Sinaga, M. O. (2017). Potensi Pengembangan Tradisi Etnobotani Sebagai Ekowisata Berkelanjutan : Studi Kasus Suku Mentawai di Pulau Siberut , Kepulauan Mentawai. *Jurnal Pro-Life*, *4*(2), 364–374.

Rodrigues, E., Seixas, C. S., Sauini, T., & Adams, C. (2022). The importance of ethnoecological studies for the conservation and sustainable use of biodiversity: a critical analysis of six decades of support by FAPESP. *Biota Neotropica*, *22*(special).

Sabila, F. W., & Purwanti, E. Y. (2020). Pendakian Di Jawa Tengah : Motivasi Ekowisata Dan Perilaku Wisatawan. *Jurnal Dinamika Ekonomi Pembangunan*, *2*(3), 67.

Samani, D., Bosak, K., & Halvorson, S. J. (2023). Community-Centered Sustainable Ecotourism Planning in the Bossou Forest Reserve, Guinea, West Africa. *Sustainability (Switzerland)*, *15*(5).

Setyawati, T., Narulita, S., Bahri, I. P., & Raharjo, G. T. (2015). *A Guide Book to Invasive Plant Species in Indonesia*. Research, Development and Innovation Agency. Ministry of Environment and Forestry.

Soepadmo, E., & van Steenis, C. G. G. J. (1972). Fm1S1972007001014. *Flora Malesiana - Series 1, Spermatophyta*, 265–403.

Suvanto, S. (2020). *The Protection of Traditional Knowledge associated with Genetic Resources by using Community Protocols* (Issue August).

Swamy, L., Drazen, E., Johnson, W. R., & Bukoski, J. J. (2018). The future of tropical forests under the United Nations Sustainable Development Goals. *Journal of Sustainable Forestry*, *37*(2), 221–256.

Świgost, A. (2015). The Transformation of the Natural Environment of the Polish and Ukrainian Bieszczady Mountains due to Tourism and Other Forms of Human Pressure. *Current Issues of Tourism Research*, *5*(nr 2), 27–35.

Tjitrosoedirdjo., S. S., Mawardi., I., & Tjitrosoedirdjo, S. (2016). *75 Important Invasive Plant Species in Indonesia*. SEAMEO BIOTROP Southeast Asian Regional Centre for Tropical Biology.

Ulian, T., Sacandé, M., Hudson, A., & Mattana, E. (2017). Conservation of indigenous plants to support community livelihoods: the MGU–Useful Plants Project. *Journal of Environmental Planning and Management*, *60*(4), 668–683.

Uslan, Abdullah, N., Imami, M. K. W., & Aiman, U. (2024). the Effectiveness of the Local Knowledge-Based Module (Lkbm) To Improve Students' Scientific Literacy and Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *13*(1), 147–161.

Utami, N. R., Rahayuningsih, M., Abdullah, M., & Ahmad, T. A. (2019). Preliminary study of ethnobotany based on local wisdom in Mount Ungaran Central Java. *Journal of Physics: Conference Series*, *1321*(3).

Whitney, C. (2019). ethnobotanyR: Calculate Quantitative Ethnobotany Indices [R Package Version 0.1.5],. In *The Comprehensive R Archive Network (CRAN)*. https://cran.r-project.org/web/packages/ethnobotanyR/vignettes/ethnobotanyr_vignette.html

Zhou, Q., Xin, Z., Wang, Y., Miao, R., Liu, Z., Zong, L., Li, X., Ma, Q., Liang, W., Yu, H., & Wang, L. (2022). The Adaptive Capacity of Alien and Rare Species in China. *Forests*, *13*(12), 1–13.