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Preliminary Study of Dominance and Ethnobotany of Medicinal Plants on the Mayung Polak Trail, Mount Rinjani National Park

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Abstrak

This research examines the ecological dominance and ethnobotanical potential of medicinal plants found along the Mayung Polak Waterfall Trail, located in the Timbanuh Resort of Mount Rinjani National Park (MRNP). By combining vegetation analysis with descriptive ethnobotany, the study investigates how plant community structure correlates with the medicinal potential of the species in the area. Vegetation data were obtained by placing 2 × 2 m plots (4 m²) at 200-meter intervals along the trail, alternating between the left and right sides. The vegetation analysis calculated density, frequency, and the Important Value Index (IVI) to evaluate the dominance of species. Ethnobotanical information was collected through direct field observations and a review of existing ethnobotanical and ethnopharmacological literature, without conducting formal interviews. The results show that the medicinal plant community is dominated by species with high IVI values, such as *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis*. These species act as key elements in the understory and have been widely recognized for their medicinal uses in traditional practices. Their ecological dominance indicates strong adaptability to the moderate disturbances of the trail environment. The combined use of IVI analysis and ethnobotanical data underscores that species with higher ecological dominance are more likely to have significant medicinal uses, offering valuable insights for the sustainable management and conservation of medicinal plants along MRNP's tourist trails.

Keywords: medicinal plants, ethnobotany, tourist trail, Gunung Rinjani National Park.

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INTRODUCTION

Medicinal plants have long been an essential part of human cultures worldwide, particularly in indigenous communities, where traditional knowledge of plant-based medicines is crucial for health and healing. In the tropics, particularly in biodiversity-rich ecosystems like tropical forests, medicinal plants represent not only a valuable resource for health care but also an integral component of the forest ecosystem. The use of plants in traditional medicine has deep historical roots and continues to play a significant role in the health care systems of many communities, especially in rural and remote areas (Cunningham, 2001; Fabricant & Farnsworth, 2001).

Ecologically, the role of medicinal plants in forest ecosystems is multifaceted. These plants often occupy distinct niches within the ecosystem, particularly in the understory, where they coexist with other plant species and contribute to biodiversity.

The dominance of particular plant species in a community can reveal important information about environmental conditions and ecological interactions. Dominant species are typically those that can withstand environmental disturbances, adapt to specific conditions, and sustain high levels of reproduction and growth (Mueller-Dombois & Ellenberg, 1974; Kent, 2012). The ecological dominance of these species is therefore not only indicative of their environmental suitability but also their potential for sustainable use, particularly in the case of medicinal plants.

Ecological dominance is a concept used to describe the relative abundance or biomass of species within a given community. In plant ecology, dominant species are those that have a significant influence on the structure, composition, and function of the community (Grime, 2001). In forest ecosystems, dominant species can influence factors such as light availability, soil nutrient cycling, and competition for resources, thus shaping the conditions for other plant species.

Dominance is typically measured using indices like the Important Value Index (IVI), which combines multiple ecological parameters, such as density, frequency, and dominance, to assess the relative importance of each species in a community (Kent, 2012). In ecosystems that are subjected to disturbances, such as human activity, the dominance of certain species often changes, which can affect the composition of the plant community. This dynamic is particularly important in conservation contexts, where understanding which species are dominant can inform management practices aimed at maintaining biodiversity and ecosystem services (Pickering & Hill, 2007).

Ethnobotany, the study of the relationships between people and plants, is a critical field for understanding how local communities utilize and interact with medicinal plants. This discipline provides insights into traditional knowledge, usage patterns, and the cultural significance of plants. Ethnobotanical studies often focus on documenting plant species used in traditional medicine, understanding the knowledge systems behind their use, and assessing the sustainability of these practices in the face of modern challenges such as climate change, habitat loss, and over-exploitation (Albuquerque et al., 2014; Cunningham, 2001).

Medicinal plants are not only valued for their pharmacological properties but also for their social and cultural roles. In many indigenous communities, medicinal plants are closely tied to local traditions, spiritual practices, and social systems. The use of these plants often reflects a deep understanding of local ecosystems and a sustainable approach to resource use (Fabricant & Farnsworth, 2001). The integration of ethnobotany with ecological research provides a comprehensive view of how medicinal plants function within their ecosystems and how they can be conserved and managed sustainably.

Conservation areas, especially national parks and other protected areas, are critical for preserving biodiversity and maintaining ecosystem services. These areas often harbor a wealth of plant species, including many that are used for medicinal purposes. For example, the Mount Rinjani National Park (MRNP) in Indonesia is one of the most biodiverse areas in Southeast Asia, with a rich variety of flora, including medicinal plants that are utilized by local communities for traditional healing. Despite the recognized importance of these ecosystems, conservation areas are increasingly facing pressures from human activities such as tourism, agriculture, and infrastructure development (Pickering & Hill, 2007; Ballantyne & Pickering, 2015).

Tourism, especially in protected areas like MRNP, can have both positive and negative impacts on biodiversity. On one hand, ecotourism can raise awareness of environmental issues and provide economic incentives for conservation efforts. On the other hand, it can lead to habitat degradation, soil erosion, and the disruption of local wildlife and plant communities (Ballantyne & Pickering, 2015). The presence of medicinal plants in tourist areas presents unique challenges, as these plants are often harvested for local use or commercial purposes, which may threaten their long-term viability (Pickering & Hill, 2007).

The Mayung Polak Waterfall Trail in MRNP represents a key example of a tourism area within a protected ecosystem that may harbor a wealth of medicinal plants. This trail, located in the Timbanuh Resort area, provides a unique opportunity to study the relationship between plant community structure and the medicinal potential of the species present. The biodiversity of the trail, particularly the understory vegetation, plays a crucial role in maintaining the overall health of the ecosystem and provides valuable resources for local communities.

Research on the plant species along the trail can provide important insights into the ecological dynamics of the area, as well as the potential for sustainable use of medicinal plants. The Mayung Polak Trail, like other tourist trails in conservation areas, is subject to varying levels of disturbance, including foot traffic, waste disposal, and the collection of plants for medicinal or ornamental purposes. Understanding how plant species in this area adapt to these disturbances and identifying those species with high ecological dominance can inform management strategies aimed at balancing conservation with the sustainable use of natural resources.

The integration of ecological and ethnobotanical approaches in studies of medicinal plants is essential for a holistic understanding of plant communities in conservation areas. While ecological analysis helps determine the structure and function of plant communities, ethnobotany provides context for the cultural and medicinal significance of these plants. By combining both perspectives, researchers can better understand the sustainability of traditional plant use and how these practices can be integrated into conservation strategies. In the case of MRNP and the Mayung Polak Waterfall Trail, integrating vegetation analysis with ethnobotanical knowledge can help identify key species that are both ecologically dominant and culturally important. Species such as *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis* are examples of plants that play crucial roles in the ecosystem while also being valued for their medicinal properties. The identification of these species and their ecological significance can inform conservation strategies that promote both biodiversity preservation and sustainable plant use.

Conserving medicinal plants in protected areas presents both challenges and opportunities. One of the main challenges is the growing demand for medicinal plants, which can lead to overharvesting and the depletion of local populations (Rahayu et al., 2006). In addition, habitat degradation, invasive species, and climate change can further threaten the survival of these plants. As a result, it is essential to develop management practices that ensure the sustainable use of medicinal plants without compromising the integrity of the ecosystem. On the other hand, there are significant opportunities for promoting the conservation of medicinal plants in protected areas through education, community involvement, and sustainable harvesting practices. Ecotourism can play a key role in raising awareness about the

value of medicinal plants and their role in conservation. By educating visitors about the importance of these plants and encouraging responsible behavior, it is possible to reduce the negative impacts of tourism and promote sustainable practices.

Methods

Study Area

The study was conducted along the Mayung Polak Waterfall Trail, located in the Timbanuh Resort area within the boundaries of Mount Rinjani National Park (MRNP), located in Nusa Tenggara Barat, Indonesia. MRNP is one of Indonesia's most significant conservation areas and a biodiversity hotspot, containing rich tropical forests and endemic species. The park's complex ecosystems support a wide variety of plant species, including those used in traditional medicine.

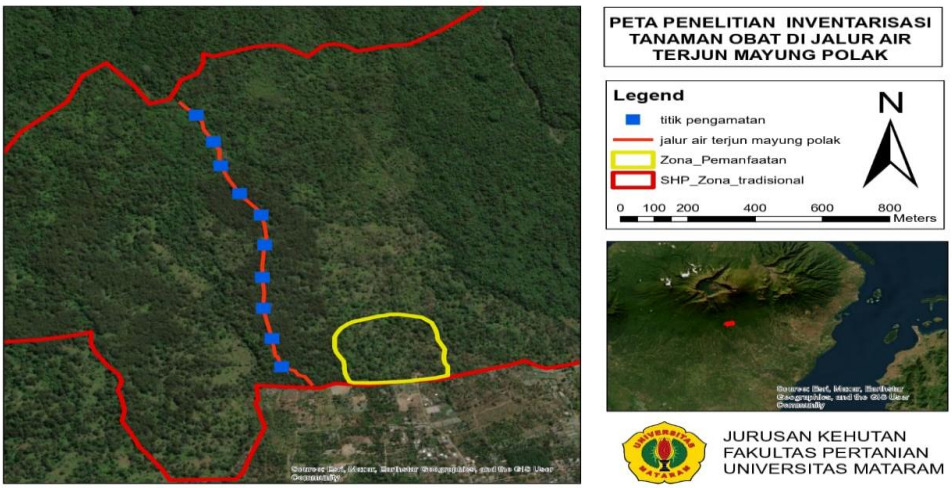

Figure 1. Research location

The Mayung Polak Waterfall Trail is a popular tourist route within the park, characterized by moderate to steep terrain, with a mixed vegetation structure, primarily consisting of secondary forest and riparian habitats. This trail, like many ecotourism sites, experiences light to moderate human disturbance, which can impact plant community structure and composition. The plant communities along the trail are predominantly dominated by understory plants such as herbs, shrubs, and small trees. This ecological setting provided an ideal location to study the dominance of medicinal plants in relation to their environmental and ethnobotanical significance.

Research Design

This study used a combination of vegetation analysis and descriptive ethnobotany to assess the ecological dominance and ethnobotanical potential of medicinal plants in the study area. The integrated approach allowed for a comprehensive understanding of the relationship between plant community structure and the traditional use of plants, specifically those with medicinal properties. The research focused on plant species found along the Mayung Polak Waterfall Trail, with an emphasis on medicinal plants, which have known ethnobotanical significance for local communities. The methodology was designed to identify and quantify plant species in the study area while simultaneously linking these species with traditional

medicinal uses. The study was conducted over two months, from May to June 2025, during which the vegetation was surveyed, and ethnobotanical data were gathered.

Data Collection

Sampling Method

The vegetation data were collected using a systematic plot-based sampling method, which is commonly used in vegetation studies for its efficiency in quantifying plant diversity, composition, and dominance. For this study, we used 2 × 2 m plots (4 m^2), which are appropriate for capturing the herbaceous and shrub layers of the understory in forest ecosystems. Ten sampling plots were established along the trail at intervals of 200 meters, alternating between the left and right sides of the path. This systematic placement ensured that the entire study area was adequately sampled, covering different ecological conditions encountered along the trail.

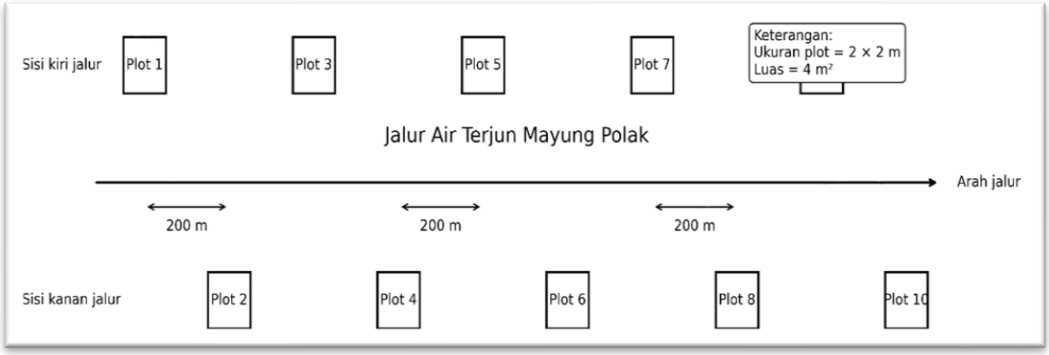

Figure 2. Design of placement of medicinal plant observation plots along the Mayung Polak Waterfall route

Each plot was thoroughly surveyed to document the species present. In addition to identifying species, the number of individuals of each species was counted, and the percentage cover of each species was estimated visually. This method provides a good balance between accuracy and practicality, particularly in the dense understory where plant species are often overlapping or difficult to distinguish.

Vegetation Parameters

Several important vegetation parameters were measured to assess plant community structure and dominance. These included:

- Density (K): The total number of individuals of each species per unit area. This parameter gives an idea of how abundant each species is in the community.
- Frequency (F): The percentage of plots in which a species occurs. This helps to understand the spread or distribution of species across the study area.
- Relative Density (KR): This is the ratio of the density of a species to the total density of all species in the study area, expressed as a percentage.
- Relative Frequency (FR): This is the ratio of the frequency of a species to the total frequency of all species, expressed as a percentage.

The Important Value Index (IVI) was then calculated to determine the dominance of each species. The IVI combines relative density and relative frequency to provide a composite score for each species, allowing for a straightforward comparison of species dominance in the community. The formula for IVI is: Species with high IVI values are considered dominant species and are key players in structuring the community. These species are expected to have significant ecological roles and may also be candidates for sustainable use, particularly if they are medicinal plants.

Data Collection Method

Ethnobotanical data were collected through direct field observations and a literature review. Field observations involved recording plant species that were identified as medicinal plants based on visual identification and known local uses, particularly those documented in previous ethnobotanical studies of the region. The plants were observed in their natural habitat, and information on their medicinal uses was gathered by consulting available ethnobotanical and ethnopharmacological literature.

The literature review focused on documented sources about the traditional use of plants in Southeast Asia, particularly in Wallacea, the region where MRNP is located. Key sources included works that catalogued the medicinal properties of plants commonly used in Indonesian traditional medicine (Albuquerque et al., 2014; Fabricant & Farnsworth, 2001). Local knowledge from non-formal interviews and interactions with park rangers and community members helped supplement the information collected from literature, providing insights into the contemporary uses of medicinal plants along the trail. However, formal interviews with local community members were not part of the study to respect the ethical constraints and limitations of access.

For each plant species, the following ethnobotanical information was recorded:

1. Medicinal uses: The specific ailments or conditions the plant is used to treat in traditional medicine.
2. Plant parts used: The specific parts of the plant that are utilized (e.g., roots, leaves, bark).
3. Mode of use: How the plant is typically prepared and administered (e.g., as a decoction, infusion, poultice).
4. Cultural significance: Any cultural or ritualistic associations with the plant, if available from the literature or local knowledge.

The integration of both ecological data and ethnobotanical data allows for a fuller understanding of the medicinal plants' role in the ecosystem and their potential for sustainable use.

Data Analysis

Vegetation Data Analysis

The vegetation data were analyzed using both descriptive and quantitative methods. Descriptive analysis included calculating basic statistics for species abundance, frequency, and the diversity of the plant community in the study plots. The primary tool for determining species dominance in this study was the Important Value Index (IVI). As described earlier, the IVI combines the relative density and frequency of species, providing a single, easy-to-interpret value for each species that represents its ecological dominance in the plant community.

Species with high IVI values were further categorized as key species in the understory. These species were deemed ecologically significant, as their presence and dominance could influence the structure of the entire plant community. High IVI values also suggest that these species are more likely to be targeted for traditional medicinal use, which could influence their conservation status. The species richness and evenness of the plant community were also calculated using Shannon-Wiener

Diversity Index (H'). This index accounts for both the number of species (richness) and their relative abundance (evenness), providing a measure of overall biodiversity within the study area.

Ethnobotanical Data Analysis

Ethnobotanical data were analyzed descriptively, aiming to establish patterns of medicinal plant use among the species found in the study area. For each medicinal plant, the **diversity of uses** was categorized, with plants being classified based on the range of ailments they are used to treat. Plants with a narrow range of uses were categorized separately from those with a broad range of uses, as this could influence their potential for widespread use in traditional medicine and their conservation priority.

The relationship between species dominance (based on IVI) and medicinal use potential was explored qualitatively. Species with high IVI values were examined to determine if their ecological dominance correlated with broader or more diverse medicinal uses. This analysis is crucial in identifying species that may not only be ecologically dominant but also of significant cultural value.

Integration of Ecological and Ethnobotanical Data

Finally, the results from the vegetation analysis and ethnobotanical survey were integrated to understand the ecological-ethnobotanical linkage. This integration aimed to answer questions about how dominant species in the plant community are utilized in traditional medicine and whether ecologically dominant species are more likely to be valued for their medicinal properties. The integrated analysis also highlighted the importance of these species for conservation planning, with the goal of ensuring that dominant medicinal plants are protected from over-harvesting and habitat degradation.

Ethical Considerations

Ethical considerations were taken into account throughout the study. As formal interviews with local communities were not conducted, all ethnobotanical information was sourced from secondary literature, minimizing the risk of exploitation. In addition, the research adhered to the principles of **biocultural conservation**, ensuring that the cultural knowledge of local communities was respected and that the potential benefits of the study contributed to conservation efforts and sustainable management practices.

To improve the "Discussion" section of your manuscript, I will enhance the clarity, depth, and scientific rigor of the analysis. The discussion will be expanded to address key points in greater detail, link the findings to the broader literature, and interpret the results within the context of your research objectives.

DISCUSSION

The primary objective of this study was to examine the ecological dominance of medicinal plants along the Mayung Polak Waterfall Trail in Mount Rinjani National Park (MRNP). Our findings revealed that certain species, particularly *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis*, dominated the understory of the trail and exhibited high values of the Important Value Index (IVI), highlighting their

ecological significance within the plant community. This dominance is particularly noteworthy as these species have well-documented ethnobotanical uses, indicating a potential synergy between ecological prominence and medicinal value.

The species composition and number of medicinal plants found along the Mayung Polak Waterfall Trail provide an initial overview of the understory plant community structure on the nature trail in Mount Rinjani National Park. The data in Table 1 show variations in the number of individuals across species and families, reflecting the plants' level of adaptation, life strategies, and response to environmental conditions and mild anthropogenic disturbances.

Table 1. Composition of Medicinal Plant Types

No	Family	Scientific Name	Number of Individuals
1	*Amaranthaceae*	*Cyathula achyranthoides* (Kunth) Moq.	37
2	*Asteraceae*	*Ageratina riparia* (Regel) R.M.King & H.Rob.	11
3		*Erechtites valerianifolia* (Link. Ex. Wolf) Less. Ex. Dc	15
4		*Mikania micrantha* Kunth	21
5		*Acmella paniculata* (Wall. ex DC.) R.K.Jansen	26
6		*Elephantopus mollis* Kunth	60
7	*Cloranthaceae*	*Chloranthus officinalis* Blume	103
8	*Cyperaceae*	*Cyperus Brevifolius* Rottb.	6
9		*Cyperus Rotundus* L.	25
10	*Fabaceae*	*Desmodium tortuosum* (Sw.) DC.	33
11	*Piperaceae*	*Piper Retrofractum* Vahl.	3
12		*Piper Nigrum* L.	67
13	*Poligonaceae*	*Poligonum Chinense* L.	45
14	*Rosaceae*	*Rubus Moluccanus* Linn.	21
15	*Rubiaceae*	*Borreria Laevis* (Lamk.) Griseb	4
16	*Selaginellaceae*	*Selaginella Doederleinii* Hieron	14
17	*Urticaceae*	*Pouzolzia zeylanica* (L.) Benn.	17
18	*Verbenaceae*	*Clerodendron paniculatum* L.	11
19		*Stachytarpheta Jamaicensis* (L). Vahl	37
Amount			**556**

Source: Primary Data, 2025

Ecological dominance is a fundamental concept in plant community ecology, reflecting the relative abundance, frequency, and biomass of species within a community (Grime, 2001). The high IVI values for *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis* suggest that these species play a crucial role in shaping the community structure along the trail. Dominant species often influence various ecological processes such as nutrient cycling, light availability, and competition for resources. In the case of *Chloranthus officinalis*, its widespread distribution and high frequency across plots suggest that it is particularly well-suited to the environmental

conditions of the Mayung Polak Waterfall Trail, which likely includes factors such as partial shade, humidity, and stable soil moisture levels.

Furthermore, these species' ecological dominance might reflect their high adaptability to disturbances, such as those introduced by tourism activities along the trail. The moderate disturbance regime that characterizes many tourist trails, with trampling and occasional plant harvesting, may create an environment that favors certain pioneer or disturbance-tolerant species. The dominance of these species in disturbed habitats is consistent with findings from other studies, which have shown that species such as *Elephantopus mollis* and *Piper nigrum* are often found in disturbed environments due to their robust regenerative capacities (Magurran, 2013). Their ability to thrive in these conditions may also contribute to their role as key species in the plant community, further solidifying their importance in both ecological and ethnobotanical terms.

The species identified as ecologically dominant—*Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis*—also hold significant ethnobotanical value. These species are widely recognized for their medicinal properties, which have been well-documented in various ethnobotanical and pharmacological studies (Cunningham, 2001; Albuquerque et al., 2014). *Chloranthus officinalis*, for example, is known for its use as an anti-inflammatory and antimicrobial agent in traditional medicine across Southeast Asia. Similarly, *Piper nigrum* (black pepper) is not only a culinary spice but also a widely used medicinal plant, known for its anti-inflammatory, antioxidant, and digestive properties (Fabricant & Farnsworth, 2001).

The structure of the medicinal plant community along the research path was analyzed using the Importance Value Index (IVI) to identify the level of ecological dominance of each species. IVI is an important indicator that describes the relative role of a species in a plant community based on its density and frequency (Mueller-Dombois & Ellenberg, 1974; Kent, 2012).

Table 2. Importance Value Index of Medicinal Plants

No	Family	Species	KR (%)	FR (%)	INP
1	Chloranthaceae	*Chloranthus officinalis* Blume	18,13	18,13	**36,27**
2	Piperaceae	*Piper nigrum* L.	11,80	11,80	**23,59**
3	Asteraceae	*Elephantopus mollis* Kunth	10,56	10,56	**21,13**
4	Polygonaceae	*Polygonum chinense* L.	7,92	7,92	**15,85**
5	Amaranthaceae	*Cyathula achyranthoides* (Kunth) Moq.	6,51	6,51	**13,03**
6	Verbenaceae	*Stachytarpheta jamaicensis* (L). Vahl	6,51	6,51	**13,03**
7	Fabaceae	*Desmodium tortuosum* (Sw.) DC.	5,81	5,81	**11,62**
8	Asteraceae	*Acmella paniculata* (Wall. ex DC.) R.K.Jansen	4,58	4,58	**9.15**
9	Cyperaceae	*Cyperus rotundus L.*	4,40	4,40	**8,80**
10	Asteraceae	*Mikania micrantha* Kunth	3,70	3,70	**7,39**
11	Rosaceae	*Rubus moluccanus* Linn.	3,70	3,70	**7,39**
12	Urticaceae	*Pouzolzia zeylanica* (L.) Benn.	2,99	2,99	**5,99**
13	Asteraceae	*Erechtites valerianifolia (*Link. Ex. Wolf*)* Less. Ex. Dc	2,64	2,64	**5,28**
14	Selaginellaceae	*Selaginella Doederleinii* Hieron	2,46	2,46	**4,93**
15	Asteraceae	*Ageratina riparia* (Regel) R.M.King & H.Rob.	1,94	1,94	**3,87**

No	Family	Species	KR (%)	FR (%)	INP
16	Verbenaceae	*Clerodendron paniculatum* L	1,94	1,94	**3,87**
17	Cyperaceae	*Cyperus Brevifolius* Rottb.	1,06	1,06	**2,11**
18	Rubiaceae	*Borreria Laevis* (Lamk.) Griseb	0,70	0,70	**1,41**
19	Piperaceae	*Piper Retrofractum* Vahl.	0,53	0,53	**1,06**
Total					**200**

Source: Primary Data, 2025

The identification of these species as both ecologically dominant and medicinally valuable underscores the potential for sustainable use of medicinal plants in conservation areas. Species that are both dominant and widely utilized are particularly important for conservation planning, as they represent a critical intersection between biodiversity preservation and human well-being. In this context, conservation efforts aimed at protecting these key species could contribute to maintaining both ecosystem integrity and the sustainable use of traditional plant resources. However, the ecological dominance of these species should also be carefully managed to prevent over-harvesting, especially as they are likely to be targeted for medicinal use by local communities and tourists.

Moreover, the medicinal value of these species highlights the importance of integrating ethnobotany with conservation biology. While ecological research provides insights into the environmental conditions that support these species, ethnobotanical research enriches our understanding of their value to local communities. In MRNP, these plants represent not only a part of the natural heritage but also a resource for local health care and cultural practices. The integration of these two approaches can thus inform more holistic and culturally sensitive conservation strategies that both preserve biodiversity and respect traditional knowledge systems.

The plant community along the Mayung Polak Waterfall Trail was characterized by moderate species richness, with a diverse array of species recorded across the study plots. The species diversity and composition reflect the trail's ecological characteristics, which include a mix of disturbed and semi-disturbed habitats. The dominance of a few species, such as *Chloranthus officinalis* and *Piper nigrum*, in these habitats is in line with the concept of species dominance as a response to disturbance regimes. The ability of these species to thrive in the understory of a secondary forest suggests that they possess strong adaptive traits that enable them to persist in environments with fluctuating conditions, such as those caused by human activity (Magurran, 2013; Kent, 2012).

In addition, our findings on the Shannon-Wiener Diversity Index (H') suggested that the community along the trail is moderately diverse. However, the relatively high abundance of a few dominant species (as indicated by the IVI) means that while biodiversity is present, it may be dominated by a small number of species. This can have implications for the overall resilience of the ecosystem. A community dominated by a few species may have less resilience to environmental changes, as it could be more vulnerable to disturbances that affect those key species (Grime, 2001). Therefore, ensuring the conservation of both dominant and lesser-known species is critical for maintaining the ecological health of the trail and the broader MRNP ecosystem.

The findings of this study have significant implications for the management and conservation of medicinal plants in MRNP, especially along the Mayung Polak Waterfall Trail. The ecological dominance of certain medicinal species, combined with their high ethnobotanical value, suggests that these species should be considered a priority in conservation planning. Species such as *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis* represent key species in the understory community, and their protection is essential for maintaining the ecological balance of the trail's plant community.

Furthermore, the presence of medicinal plants in a popular ecotourism area underscores the need for sustainable harvesting practices and visitor education. Over-harvesting and the commercialization of medicinal plants, especially those with high medicinal value, can lead to the depletion of local populations and disrupt the ecological functions that these plants provide (Pickering & Hill, 2007). Sustainable harvesting strategies, such as regulated collection and community-based management, could help mitigate the risks of over-exploitation while ensuring that local communities can continue to benefit from these valuable resources. Educational programs aimed at raising awareness among tourists about the importance of medicinal plants and their role in the ecosystem could also contribute to reducing the pressure on these species.

In addition, future research should focus on monitoring the population dynamics of these key species to assess the long-term impacts of tourism and other human activities on their populations. The application of **ecological monitoring tools**, such as remote sensing and periodic vegetation surveys, can help track changes in species abundance and distribution over time, providing essential data for adaptive management strategies.

CONCLUSION

This study has provided valuable insights into the ecological dominance and ethnobotanical potential of medicinal plants along the Mayung Polak Waterfall Trail, located in the Timbanuh Resort area of Mount Rinjani National Park (MRNP). By integrating vegetation analysis with ethnobotanical data, we have identified several key species that play a dominant role in the plant community while also holding significant medicinal value for local communities.

The findings highlight that *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis* are not only ecologically dominant, as reflected by their high Important Value Index (IVI), but are also widely used in traditional medicine. These species exhibit high adaptability to the disturbance-prone environment of the trail, likely contributing to their ecological dominance. The integration of these species' ecological significance with their ethnobotanical roles emphasizes the crucial connection between biodiversity and local cultural practices, offering a unique perspective on the potential for sustainable use and conservation.

Moreover, the results underscore the importance of considering both ecological and ethnobotanical factors in the management and conservation of medicinal plants in protected areas like MRNP. Given the growing demand for medicinal plants and the pressures posed by ecotourism, there is a need for careful, regulated management to prevent over-harvesting and ensure the long-term viability of these valuable resources. This can be achieved through sustainable harvesting practices, community-

based management, and educational programs for tourists that promote awareness of the importance of these plants for both ecological balance and cultural heritage.

In conclusion, this study contributes to the broader field of conservation biology and ethnobotany by demonstrating the importance of integrating ecological and cultural perspectives into the management of natural resources. By protecting key medicinal plant species and their habitats, MRNP can serve as a model for sustainable conservation practices that benefit both biodiversity and local communities. Future research focused on long-term monitoring and the development of adaptive management strategies will be crucial for ensuring the continued health and sustainability of the medicinal plant community along the Mayung Polak Waterfall Trail.

RECOMMENDATIONS

Based on the findings from this study, several recommendations can be made to enhance the conservation and sustainable management of medicinal plants along the Mayung Polak Waterfall Trail, within Mount Rinjani National Park (MRNP). These recommendations aim to balance biodiversity conservation with the sustainable use of plant resources, particularly those with ethnobotanical significance.

1. Implementation of Sustainable Harvesting Practices

Given the high ethnobotanical value of species such as *Chloranthus officinalis*, *Piper nigrum*, and *Elephantopus mollis*, which are both ecologically dominant and culturally significant, it is essential to develop and enforce sustainable harvesting practices. Over-harvesting of medicinal plants could lead to a decline in their populations, which in turn could affect the overall ecological balance of the area. It is recommended that:

- **Harvesting quotas** be established for medicinal plants, with annual limits based on the species' regenerative capacities and ecological roles.
- **Regulated collection** procedures should be put in place, including designated areas for plant collection that minimize environmental impacts.
- **Monitoring of plant populations** should be conducted regularly to track changes in species abundance and health, ensuring that harvesting does not exceed sustainable levels.

2. Promotion of Community-Based Management

The involvement of local communities in the management and conservation of medicinal plants is essential for ensuring both the ecological health of MRNP and the continued availability of these plants for traditional use. Community-based management approaches can integrate local knowledge and traditional practices into formal conservation strategies. It is recommended that:

- **Local communities** be actively engaged in decision-making processes related to medicinal plant management, especially regarding harvesting practices and conservation efforts.
- **Capacity-building programs** be developed to empower local communities with the skills and knowledge necessary to manage medicinal plant resources sustainably.
- **Community-run nurseries** be established to propagate medicinal plants, ensuring a sustainable supply for both traditional and commercial use, while reducing pressure on wild populations.

3. Ecotourism and Education Initiatives

Ecotourism in MRNP provides both economic benefits and the potential for raising awareness about the importance of medicinal plants and biodiversity conservation. However, without proper management, ecotourism can lead to negative environmental impacts, including over-harvesting and habitat degradation. To ensure that tourism contributes positively to conservation efforts, it is recommended that:

- **Visitor education programs** be implemented to raise awareness about the ecological and cultural significance of medicinal plants along the Mayung Polak Waterfall Trail. This can be done through interpretive signage, guided tours, and educational materials that inform tourists about the medicinal uses of plants and the need for their protection.
- **Sustainable tourism practices** should be promoted, including limiting the collection of plants by tourists and encouraging respect for the natural environment. Ecotourism operators should be trained to educate visitors on these principles.
- **Revenue from tourism** be reinvested into conservation and community development programs, ensuring that the local community benefits from ecotourism while promoting the protection of medicinal plant species.

4. Long-Term Ecological Monitoring and Research

Monitoring the ecological health of medicinal plant species and their habitats is crucial for adapting conservation strategies to changing environmental conditions. Long-term ecological monitoring programs should be established to track the populations of key medicinal plants, the effects of tourism on plant communities, and any potential threats such as invasive species or climate change. It is recommended that:

- **Regular surveys** of medicinal plant populations along the Mayung Polak Waterfall Trail be conducted to assess their health, distribution, and abundance.
- **Climate change impacts** on medicinal plants be monitored, as shifts in temperature and precipitation patterns could affect plant growth and distribution. Research into the potential effects of climate change on key species should be prioritized.
- **Research on plant regeneration** be conducted to understand the reproductive biology and growth patterns of dominant medicinal species, ensuring that conservation strategies are based on solid ecological knowledge.

5. Integration of Ecological and Ethnobotanical Approaches

This study has demonstrated the value of integrating ecological and ethnobotanical perspectives in the conservation of medicinal plants. To further enhance the effectiveness of conservation efforts, it is recommended that:

- **Ethnobotanical data** continue to be collected and incorporated into management plans, ensuring that conservation practices reflect local cultural values and the needs of the community.
- **Collaboration with local health practitioners** and traditional healers be established to share knowledge about medicinal plant uses and ensure that conservation strategies align with traditional practices.
- **Ecological and ethnobotanical research** be integrated into park management, helping to develop more comprehensive and culturally sensitive conservation strategies.

6. Habitat Restoration and Protection

As some medicinal plant species along the trail may be vulnerable to disturbance or habitat degradation, habitat restoration and protection efforts are essential to maintaining healthy plant populations. It is recommended that:

- **Restoration projects** be implemented in areas where plant populations are in decline due to disturbances caused by human activity. These projects should focus on restoring the natural habitats of medicinal plants and other critical species.
- **Buffer zones** around ecologically sensitive areas, such as the Mayung Polak Waterfall Trail, be established to limit human impact and protect plant communities from over-harvesting, trampling, and other disturbances.
- **Invasive species management** be prioritized to prevent non-native species from outcompeting or displacing native medicinal plants.

7. Policy Development and Enforcement

Lastly, it is crucial to develop and enforce policies that protect medicinal plants within MRNP and the surrounding regions. Government and park authorities must work together to ensure that the legal frameworks for conservation are robust and effectively implemented. Recommendations include:

- **Strengthening the enforcement of existing conservation regulations**, including those related to the collection and use of medicinal plants in protected areas.
- **Creating new policies** that specifically address the sustainable use and conservation of medicinal plants, with a focus on balancing ecological protection and community needs.
- **Collaboration between stakeholders**, including local communities, ecotourism operators, government agencies, and NGOs, to develop comprehensive policies for

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