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The Diversity Index and Importance Value of Herbaceous Vegetation in the Joko Tarub Forest Tuban

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Abstract: This study aims to determine the diversity index and the importance value index of herbaceous plants found around the Joko Tarub Forest Tuban. The type of research is quantitative descriptive with a sampling method using the quadrat technique. The quadrates were made with a size of 1 x 1 m as many as 10, as a measurement area. The data collection technique was carried out by recording the names of plants and their numbers found in each quadrat. In addition, the area covered by each plant in the quadrat was also calculated. The data analysis was carried out by calculating the density of species, dominance, and frequency as a basis for calculating the important value index. In addition, the Shannon-Wienner diversity index was also calculated to determine the level of diversity of herbaceous plants living in the area. From the results of this study, 10 types of herbaceous plants were found which are included in 9 Families. Of the 10 types of plants found, those with a high importance value index are *Synedrella nodiflora* and *Crassocephalum crepidioides* with values of 53.61 and 44.37 respectively. The herbaceous plant diversity index in the region is in the moderate with a value of 1.89.

Keywords: Diversity index; Herbaceous; Importance index; Vegetation

Introduction

Joko Tarub Forest is a small forest, which is the name for the vegetation found around JokoTarub Lake in Plumpang District, Tuban Regency. This forest is also often referred to as the Joko Tarub Park. The vegetation that forms the Joko Tarub Forest consists of trees, especially teak trees, shrubs, and herbs. All of this vegetation forms an ecosystem that supports the survival of all flora and fauna in the area. In the 80s, this place became a tourist attraction in Plumpang District, its location is quite strategic, about 200 m from the Plumpang highway. Currently, the lake is still there but it looks poorly maintained. Visitors still often come to the location, but not to enjoy the beauty of the lake but to camp, especially school student.

Herbaceous vegetation is one of the vegetation that helps form the Joko Tarub Forest. According to (Oktavianto & Handayani, 2017), herbaceous vegetation is one of the plant vegetation that makes up the understory of the forest ecosystem, which is much smaller in size when compared to shrubs or trees. This vegetation responds more quickly to environmental changes than woody vegetation so it is very beneficial for the forest ecosystem (Löbmann et al., 2020). In addition, herbaceous vegetation can effectively improve the physical and chemical properties of the soil and the ecological environment (Yao et al., 2018). The importance of herbaceous vegetation in maintaining soil conditions was also conveyed by Hu et al. (2025), that the diversity of herbaceous plants is closely related to the soil and soil organic matter which plays an important role in the nutrient cycle, preventing soil erosion, and providing habitat for various types of fauna. In addition, herbaceous vegetation is also an important component of biodiversity in forest ecosystems and contributes to the main contribution to forest primary production (Li et al., 2025).

Herbaceous plants are short plants with a height ranging from 0.3-2 meters, have wet stems, are not cambium or not woody and have a high water content. This is as stated by Ufiza et al. (2018), that herbaceous

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plants are plants that have wet and non-woody stems, and are much smaller in size than shrubs and trees. In terms of adaptability, herbaceous plants have good adaptability to various environmental conditions, including dry and rocky environments such as the conditions of the Joko Tarub Forest. As stated by Wardila et al. (2022) that herbs have high competitiveness and adaptability to the surrounding plants, so they can grow in various places such as humid, dry, rocky, and densely shaded habitat conditions. Meanwhile, according to Laratu et al. (2014), herbs also have strong competitiveness and high adaptation to the surrounding plants (such as bushes, shrubs, and even trees) so they can grow in empty places. Herbs are cosmopolitan in nature because they spread very quickly and can grow everywhere, so their existence is very large in nature (Marhamah et al., 2016). Because of their relatively short size, herbaceous plant species can act as floor covering vegetation which is very important for retaining rainwater. Thus, herbaceous plant vegetation plays a very important role in preventing erosion of the soil layer in the forest, thus maintaining forest fertility. Thus, the existence of herbaceous vegetation in the Joko Tarub Forest is very supportive for the formation of fertile vegetation in the area, both tree and shrub vegetation.

Definitive data on what herbs are found in the Joko Tarub Forest and what the level of diversity is, until now there is no information, so it is important to conduct research. Analysis of herbaceous vegetation diversity is a quantitative method used to study the composition of vegetation related to the types and structures of herbaceous vegetation in the area and is important in ecological research (Achmad et al., 2023). In addition, according to Babo et al. (2020) diversity index analysis helps in understanding the community structure and its function in the wider ecosystem by examining the number of species in an area and the number of individuals of each species. Analysis of herbaceous vegetation can be done by making plots, then observing the morphology and identification of vegetation found in the analysis area (Panita et al., 2023). A similar statement was also stated by Nabu et al. (2024), that herbaceous vegetation analysis often involves the quadrat method to estimate species density, frequency, and dominance.

Method

This type of research is quantitative descriptive to describe the level of diversity of herbaceous vegetation in the Joko Tarub Forest, Tuban Regency. The research was conducted from June to July, 2023, at a location 50 meters to the north of Telaga Jaka Tarub, with flat, rocky land conditions, and lots of teak tree litter. Sampling was carried out using the quadrat method, namely by making sample plots measuring 1x1 meter (Hidayat, 2017) as many as 10 plots. This sample plot was made by sticking bamboo stakes surrounded by raffia rope on each side. The data collection technique was carried out by recording the names of plants found in each plot, counting the number of individuals for each type, and calculating the cover for each individual through the percentage of cover visually to then calculate the dominance of each plant. For plants that are not yet named, samples are taken and put into plastic bags and given 70% alcohol to be identified using an identification book. All plants observed are plants that are included in the herbaceous habitus. As supporting data, abiotic factors are also measured, namely air temperature, soil pH, and air humidity.

The data analysis was carried out by calculating the diversity index and the importance value of each plant found. For this purpose, density, dominance, and frequency were also calculated using the following formula (Itawarnemi et al., 2021).

$$\text{KM} = \frac{\text{Number of a spesies}}{\text{Area of sample plots}} \quad (1)$$

$$\text{KR} = \frac{\text{Absolute density of a species}}{\text{Absolute density of all species}} x100\% \quad (2)$$

$$\text{DM} = \frac{\text{Coverage area of a species}}{\text{Area of sample plots}} \quad (3)$$

$$\text{DR} = \frac{\text{Absolute frequency of a species}}{\text{Absolute frequency of all species}} x100\% \quad (4)$$

$$\text{FM} = \frac{\text{Number of plots occupied by a species}}{\text{Number of sample plots}} \quad (5)$$

$$\text{FR} = \frac{\text{Absolute frequency of a species}}{\text{Absolute Frequency of all species}} x100\% \quad (6)$$

$$\text{INP} = KR + DR + FR \quad (7)$$

Note:
KM : Absolute density
KR : Relative Density
DM: Absolute Dominance
DR : Relative dominance
FM : Absolute frequency
FR : Relative frequency
INP : Importance value

The diversity index is calculated using the Shannon-Wiener diversity index Because the Shannon-Wiener Index (H') is more sensitive to changes in species with a moderate number, making it an important tool in analyzing communities with diverse species (Raunsay et al., 2024). The formula for calculating the Shannon-Wiener diversity index is as follows (Baderan et al., 2021).

$$H' = -\sum \frac{n_i}{n} \ln \frac{n_i}{n} \quad (8)$$

Description:
H′ = Shannon-Wiener diversity index
ni = number of individuals of each species
N = number of individuals of all species

The criteria for the diversity index value of the Shannon-Wiener diversity index (H') are as follows in Table 1.

Table 1. Criteria For the Diversity Index (H') According to Shannon-Wiener

Diversity Index	Criteria
$H' < 1$	Low
$1 \leq H' \leq 3$	Medium
$H' > 3$	High

Result and Discussion

The results of observations of herbaceous plants found in the Jaka Tarub forest, with abiotic factors as supporters, namely environmental temperature of 29^0 C, soil pH of 7.5 and humidity of 80%, found 10 species of herbaceous plants consisting of 9 families with a total of 85 individuals (Table 2). Herbaceous plants in the Joko Tarub Forest area are herbs that grow under teak tree stands. This shows the adaptability of herbaceous plants both in open land and under tree stands. This condition is in accordance with the statement of Nursanti et al. (2019), that herbaceous plants are often found in open forests and are also found under tree stands. The ability of herbaceous plants to live in rocky soil environments such as conditions in the Joko Tarub Forest shows that herbaceous plants have good adaptability in various conditions. This is in line with the statement of Hidayah et al. (2022), which states that herbaceous plants are often found in various habitat conditions such as dry soil, rocky soil, and conditions influenced by several environmental factors. This statement is also reinforced by Romdhani & Farid (2023), that herbaceous plants also have a high ability to adapt to the environment and plants around them. Herbs will thrive in areas with supportive environmental factors such as pH, air temperature, humidity, salinity and soil fertility. This is in line with the statement of Herdananta et al. (2024) that the composition and abundance of herbaceous vegetation are greatly influenced by changes in environmental conditions, such as light, humidity, and soil nutrients. In addition, the structure of the herbaceous vegetation community is influenced by interspecies interactions, including competition and facilitation (Wardhani & Poejirahajoe, 2020) .

Table 2. The Types of Herbaceous Plants Found in The Joko Tarub Forest

Local Name	Latin Name	Family	ni
Rumput teki	Cyperus rotundus	Cyperaceae	12
Pletekan	Ruellia tuberosa	Acanthaceae	21
Jotang Kuda	Synedrella nodiflora	Asteraceae	20
Mint gunung	Pycnanthemum incanum	Lamiaceae	6
Sembukan	Paederia foetida	Rubiaceae	1
Jarong	Achyranthes aspera	Amaranthaceae	12
Junggul	Crassocephalum crepidioides	Asteraceae	1
Rumput galing	Cayratia trifolia	Vitaceae	1
Rumput Pita Bulu	Phalaris arundinacea	Poaceae	10
Talas Sente	Alocasia macrorrhizos	Araceae	1
Total			85

Based on the Table 2, it can be seen that the Pletekan plant (*Ruellia tuberosa*) is the plant found the most compared to other plants with a total of 21 individuals. Other herbaceous plants found in large numbers are Jotang Kuda (*Synedrella nodiflora*) with a total of 20, while other than these two plants they were found in numbers of less than 20. Referring to Santya et al. (2023) who stated that the density of a species is the number of individuals per unit area, then based on table 2 it can be said that the Pletekan plant (*Ruellia tuberosa*) has the highest density compared to other plants, followed by the Jotang Kuda plant (*Synedrella nodiflora*). The plants with the fewest, namely with only 1 individual are the Sembukan plant (*Paederia foetida*), Junggul (*Crassocephalum crepidioides*), Rumput Galing (*Cayratia trifolia*), and Talas Sente (*Alocasia macrorrhizos*), which means that the density of these plants is the lowest.

From Table 2, it can be seen that the number of individuals in each species is different. Each plant species requires suitable environmental conditions to live, so the requirements for species to live are different, where they only occupy parts that are suitable for their lives. As stated by Rahayu et al. (2020), the presence of a type of plant in an area shows the ability to adapt to the habitat and wide tolerance to environmental conditions. Plants that are suited to their environment will grow and reproduce well, conversely plants that cannot adapt to their environment will gradually disappear from the area.

All species found in the Joko Tarub Forest are included in 9 Families (Figure 1).

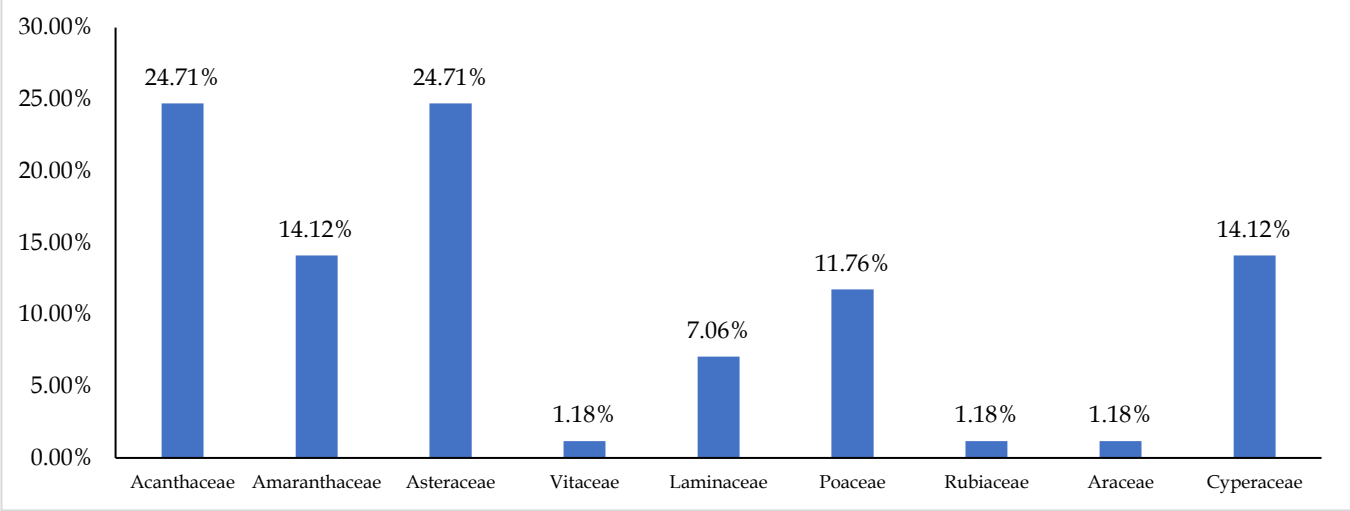

Figure 1. Number of Individuals in Each Family

The families with the largest number of individuals are Asteraceae and Acanthaceae, both with the same number of individuals, namely 24.71%, so that these two families are more dominant than other families living in the area. In other words, this condition illustrates the high species richness of the two families in the Joko Tarub Forest area. This is as stated by Ngawit et al. (2024) that the species dominance index is used to determine the species richness and balance of the number of individuals of each species in each community being compared. Jotang Kuda (*Synedrella nodiflora*) is a plant from the Asteraceae family that is found in the largest number. This condition is because in addition to the plant having good adaptation abilities to its environment, it is also because the plant has allelopathic activity that can inhibit other plants from living and growing in the area.

This is as stated by Fathiya et al. (2024), who stated that the allelopathic activity of Jotang Kuda (*Synedrella nodiflora*) reduces the chances of other species around it to survive. The ability of a plant to spread in an area depends on the ability of the species to adapt to the place of growth and associate with other plants. In addition, it is also caused by the wide relative tolerance to various ecological factors. After the Asteraceae and Acanthaceae families, then Amaranthaceae and Cyperaceae with the number of individuals each 14.12%, while Poaceae consists of 11.76%. The Lamiaceae family is 7.06% and the least is the Araceae, Rubiaceae, and Vitaceae families, each only 1.18%. The number of species in each family consists of only 1 species except for the Asteraceae family which consists of 2 species, namely Jotang Kuda (*Synedrella nodiflora*) with 20 individuals and Junggul (*Crassocephalum crepidioides*) with 1 individual. From the results of Hutasuhut (2018) is known that the largest number of genera in a family indicates that the family has high tolerance and has the ability to grow and develop to dominate an area. Based on Hutasuhut (2018) statement, it means that the Asteraceae and Acanthaceae families have high tolerance to both biotic and abiotic conditions of the Joko Tarub Forest. Therefore, both families also have the ability to grow and develop well so that they dominate the area. The importance value index for each plant that found in the Joko Tarub Forest can be seen in Table 3.

Table 3. Importance Value Index of Each Herbaceous Plant in The Joko Tarub Forest

Local Name	Latin Name	KM	KR (%)	DM	DR (%)	FM	FR(%)	INP (%)
Rumput Teki	Cyperus rotundus	1.20	14.12	47.15	13.50	0.30	10.34	37.97
Pletekan	Ruellia tuberosa	2.10	24.71	5.36	1.54	0.40	13.79	40.03
Jotang Kuda	Synedrella nodiflora	2.00	23.53	8.71	2.49	0.80	27.59	53.61
Mint Gunung	Pycnanthemum incanum	0.60	7.06	6.34	1.82	0.20	6.90	15.77
Sembuk	Paederia foetida	0.10	1.18	1.06	0.30	0.10	3.45	4.93
Jarong	Achyranthes aspera	1.20	14.12	4.26	1.22	0.40	13.79	29.13
Junggul	Crassocephalum crepidioides	0.10	1.18	138.76	39.74	0.10	3.45	44.37
Rumput Galing	Cayratia trifolia	0.10	1.18	94.56	27.08	0.10	3.45	31.71
Rumput Pita Bulu	Phalaris arundinacea	1.00	11.76	21.93	6.28	0.40	13.79	31.84
Talas Sente	Alocasia macrorrhizos	0.10	1.18	21.03	6.02	0.10	3.45	10.65
Total		8.50	100.00	349.16	100.00	2.90	100.00	

The importance value index can be used as an indication to determine the dominant species in a place. Calculation of this importance value has proven to be an important tool for understanding the ecological significance of species in various vegetation types (Vincy & Brilliant, 2024). Based on table 3, it can be seen that the highest importance value index is the Jotang Kuda plant (*Synedrella nodiflora*). This means that the Jotang Kuda (*Synedrella nodiflora*) plant is a dominant (powerful) species in the community. As stated by (Diba et al., 2022), the importance value index is a quantitative parameter used to express the level of control of a species over other species in a community. This statement is also reinforced by Ramadani et al. (2021) who stated that the important value index (INP) is used to determine the dominance of one type over another. The high INP in Jotang Kuda (*Synedrella nodiflora*) plants indicates that the plant has high tolerance to environmental conditions and is able to compete compared to other species. The greater the INP of a plant species, the greater the level of control over its habitat and vice versa, while the control of a particular species in a habitat occurs if the species in question is successful in utilizing the resources in the area compared to other species. The species with the highest INP has a greater chance of being able to maintain the growth and sustainability of its species (Alam et al., 2023; Shabirin et al., 2020). As stated by Ismaini et al. (2015) that the control of a species in a habitat indicates that the species can utilize most of the resources in its surrounding environment.

In addition to describing the level of control over a community, the importance value index also describes the role of a type of plant in the community. As stated by Ismail et al. (2017), the importance value index of a species in a community is a parameter to determine the level of role of the species in its community. Based on this, it can be interpreted that plants with a high importance value index will greatly influence their community. Based on Table 2, Jotang Kuda (*Synedrella nodiflora*) is a plant that will have a major influence on the community in the Joko Tarub Forest compared to other herbaceous plants.

Referring to the important value index criteria from (Hidayat, 2017), the categorization of INP values is as follows: INP> 42.66 is categorized as high, INP 21.96 - 42.66 is moderate, and INP <21.96 is categorized as low. Based on these criteria, the highest important value index, namely Jotang Kuda (*Synedrella* nodiflora) is 53.61, which is included in the high category. Other type that also has a high important value index is Junggul (*Crassocephalum crepidioides*) with a value of 44.37. The types that have a medium importance index value are Rumput Teki (*Cyperus rotundus*), pletekan (*Ruellia tuberosa*), Jarong (*Achyranthes aspera*), Rumput Galing (*Cayratia trifolia*), and Rumput Pita Bulu (*Phalaris arundinacea*), and the types that have a low importance index value are Mint Gunung (*Pycnanthemum incanum*) and Sembukan (*Paederia foetida*).

Data on the herbaceous plant diversity index found in the Joko Tarub Forest can be seen in Table 4. This Diversity Index functions to show the abundance of species diversity levels in each study area (Arisandy & Triyanti, 2020). From the table, it can be seen that the diversity index obtained a value of 1.89. Referring to the Shannon-Wiener diversity index (Table 1), this value is in the moderate category. The diversity index value determines how high the diversity of a species is in an area. High species diversity indicates that a community has high complexity because the interactions of species that occur in the community are very high. A community is said to have high species diversity if the community is composed of many species, conversely a community is said to have low species diversity if the community is composed of few species and if only a few are dominant. A similar statement was also conveyed by Kuncahyo et al. (2020) who stated that the species diversity of a community will be low if the community is composed of few species and there is a dominant species in the area. Conversely, a community has a high species diversity value, if the community is composed of many species and no species dominates. This statement is also in accordance with Evita et al. (2021), that a high diversity index value indicates greater species richness and evenness of abundance among species.

Table 4. Herbaceous Plant Diversity Index in the Joko Tarub Forest

Local Name	Nama Latin	ni	ni/n	ln ni/n	-(ni/n) ln (ni/n)
Rumput Teki	*Cyperus rotundus*	12	0.14	-1.96	0.28
Pletekan	*Ruellia tuberosa*	21	0.25	-1.40	0.35
Jotang Kuda	*Synedrella nodiflora*	20	0.24	-1.45	0.34
Mint Gunung	*Pycnanthemum incanum*	6	0.07	-2.65	0.19
Sembukan	*Paederia foetida*	1	0.01	-4.44	0.05
Jarong	*Achyranthes aspera*	12	0.14	-1.96	0.28
Junggul	*Crassocephalum crepidioides*	1	0.01	-4.44	0.05
Rumput Galing	*Cayratia trifolia*	1	0.01	-4.44	0.05
Rumput Pita Bulu	*Phalaris arundinacea*	10	0.12	-2.14	0.25
Talas Sente	*Alocasia macrorrhizos*	1	0.01	-4.44	0.05
Total		85		H'	1.89

The herbaceous plant diversity index in an area also describes the level of stability of a community. This is in line with Rasiska et al. (2023) that the diversity of herbaceous species can be an indicator of habitat quality and the level of disturbance in an ecosystem (Yuningsih et al., 2018). As stated by Baderan et al. (2021) that the diversity index is a vegetation parameter that has the best benefits in comparing communities, especially in terms of studying the various impacts of environmental or abiotic factor disturbances on communities, as well as understanding the state of succession and community stability (Watanabe et al., 2020). This is based on the condition that there are many types of plants in a community, so the older/more stable the condition of the community, the higher the diversity of plant species. A similar statement was also made by Heri et al. (2020), that the more stable the condition of a community, the higher the diversity of plant species. A stable community has a strong resistance to disturbances. This statement is also similar to that conveyed by Azizah (2017), who stated that the low level of plant species diversity is caused by the area where the plants live being vulnerable to various disturbances.

Table 4 shows the diversity index of herbaceous plants in the Joko Tarub Forest. The diversity index is a quantitative measure that reflects the variation of species in an ecological community (Hulopi et al., 2022; Sari et al., 2018). In addition, a similar statement was also conveyed by Andani et al. (2023), who stated that diversity is a trait that shows the characteristics of a community where these characteristics are related to the number of species owned and the number of individuals of each species in it. From Table 4, it can be seen that the diversity index of herbaceous plants in the Joko Tarub Forest is at a moderate level with a value of 1.89. This condition illustrates that the diversity of herbaceous plants in the Joko Tarub Forest is still quite good, although the area is visited a lot, the level of diversity is still at a moderate level. This condition shows that the ecosystem in the area is quite balanced, and can defend itself from ecological pressures. All components of the ecosystem, both biotic and abiotic factors, function quite well and support the survival of the ecosystem. This is as stated by Hidayah et al. (2022) that environmental factors greatly influence the diversity of herbaceous plants.

Conclusion

The results of research on herbaceous plants in the Joko Tarub Forest, found 10 types of herbaceous plants belonging to 9 families. Referring to the categorization of the importance value index (Hidayat, 2017), of the 10 types of plants, Jotang Kuda (*Synedrella nodiflora*) and Junggul (*Crassocephalum crepidioides*) are plants that have a high importance value index with values of 53.61 and 44.37 respectively. The other five plants have a medium importance value index, namely Rumput Teki (*Cyperus* rotundus) with a value of 37.97, Pletekan (*Ruellia tuberosa*) 40.03, Jarong (*Achyranthes* aspera) 29.13, Rumput Galing (*Cayratia trifolia*) 31.71 and Rumput Pita Bulu (*Phalaris arundinacea*) 31.84. Those with a low importance index are the Mint Gunung (*Pycnanthemum incanum*) with a value of 15.77, Talas Sente (*Alocasia* macrorrhizo) with a value of 10.65, and Sembukan (*Paederia foetida*) with a value of 4.93. The regional diversity index is in the medium category with a value of 1.89.

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Conflicts of Interest

All authors declare that they have no conflict of interest.

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