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Taxonomic Affinity of Poaceae Family Based on Morphological Characters

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ABSTRACT

This study aims to analyze the relationship among species in the Poaceae family based on their similarities in morphological characteristics. The method used was a taximetry method describing the taxonomic affinity based on morphological characteristics of plants, including leaves, stems, roots, flowers, and fruit. Morphological character data was compiled on Ms Excel, representing the character of each organ and morphological scoring data. Furthermore, the scoring results were analyzed with the NTSys-PC version 2.02i program, and the final results were presented as a dendrogram. The research results show five species of members of the Poaceae family, including Zea mays, Oryza sativa, Saccharum officinarum, Pennisetum purpureum and Cymbopogon citratus, showed that Zea mays and Cymbopogon citratus had the closest affinity with a coefficient of 0.47. In contrast, the most distant affinity was Pennisetum purpureum, with a coefficient of 0.25.

Hubungan Kekerabatan Family Poaceae Berdasarkan Karakter Morfologi

ABSTRAK: *Tujuan dari penelitian ini untuk menganalisis kekerabatan antar spesies dalam satu famili Poaceae berdasarkan persamaan sifat dan ciri morfologinya. Metode yang digunakan adalah metode taksimetri untuk menjelaskan kekebrabatan fenetik berdasarkan karakter morfologi tumbuhan meliputi daun, batang, akar, bunga, dan buah. Data karakter morfologi disusun pada Matriks Ms. Excel yang mewakili karakter masing-masing organ, dan data skoring morfologis. Selanjutnya hasil skoring dianalisis dengan program NTSys-PC versi 2.02i dan hasil akhir disajikan dalam bentuk dendogram. Berdasarkan hasil penelitian lima spesies anggota famili Poaceae, antara lain Zea mays, Oryza sativa, Saccharum officinarum, Pennisetum purpureum dan Cymbopogon citratus menunjukkan bahwa hubungan kekerabatan fenetik Zea mays dan Cymbopogon citratus memiliki hubungan kekerabatan yang paling dekat dengan koefisien 0.47 sedangkan kekerabatan yang paling jauh adalah Pennisetum purpureum dengan koefisien 0.25.*

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INTRODUCTION

Indonesia is one of the hotspots for plant biodiversity in the world (Cahyaningsih et al. 2021; von Rintelen, Arida, and Häuser 2017). The diversity of various types of plants can be compared between their morphological and anatomical structures. There are many differences between one plant with another plant. The less diversity of traits possessed between species, the higher the similarity, so the taxonomic affinity is getting closer. Similarity-based groupings like this are called phenetics (Simpson 2019). In a systematic study of plants, morphology is one of the basics for determining taxonomic affinity (Endress, Baas, and Gregory 2000). Plants at the same taxon family level generally have the same morphological characteristics (Tjitrosoepomo 2019).

One example of a family in the Plantae kingdom is Poaceae. This family is commonly known as the grass tribe and belongs to the class Liliopsida which is often found in tropical and subtropical regions (Simpson 2006). Species in the family Poaceae have morphological similarities in the form of lanceolate leaves, leaves that have ligules, and flowers that do not have a crown (shaped like a grain) (Steenis 2008), as well as phytomers which consist of leaves, axils, buds, insertion nodes, related internodes and, in some cases, adventitious roots (Perreta et al. 2011). The Poaceae family consists of several sub-families (tribes), including Bambusoideae, Pooideae, and Panicodeae (Steenis 2008). Some examples of plants belonging to the Poaceae family are *Oryza sativa* (rice), *Zea mays* (maize), and *Saccharum officinarum* (sugarcane) (Eroschenko 2010).

Poaceae is a family that can easily be found, and the number is very large. Besides, Poaceae also plays a role in human life, with both beneficial and detrimental effects. The beneficial role of Poaceae is that it can be used as food, board, and medicine. It was reported by (Majeed et al. 2020) that *Chrysopogon zizanioides* could be used as an anti-inflammatory, *Sorghum saccharatum* and *Themeda triandra* as malaria drugs and *Koeleria* argentia for the treatment of skin allergies. A study by (Nurjanah, Rokiban, and Irawan 2018) reported that *Cyperus rotundus* could inhibit bacteria's growth. (Arisandi, Dharmono, and Muchyar 2015) Also, Poaceae has a role as a pioneer plant, helping increase organic matter and nutrients, thus allowing intolerant plant species to come and grow. Meanwhile, the detrimental role is that many members of the Poaceae family live as weeds (Solikin 2000), for example, *Axonopus compressus, Eleusine indica, Oplismenus burmanni* and *Panicum repens* (Utami, Murningsih, and Muhammad 2020) and even the *Chionochloa* genus live as invasive plants in New Zealand (Linder et al. 2018). Various studies related to the Poaceae family include morphological descriptions and benefits for humans. Several studies related to Andropogoneae (part of the Poaceae family), biogeographic analysis (Welker et al. 2020) and Poaceae phylogeny (Huang et al. 2022) have been done. Still, few have studied the phenetic relationships of its members. Based on these morphological similarities and differences, the close relationship between species will be investigated using the taximetry method.

This research will determine the taxonomic affinity among species belonging to the Poaceae family, namely *Zea mays*, *Oryza sativa, Saccharum officinarum, Pennisetum purpureum*, and *Cymbopogon ciratus,* based on morphological characters so that it can complete the current plant identification information.

METHOD

This research was conducted in May – June 2021. Researchers used five species in the Poaceae family, including corn (*Zea mays*), rice (*Oryza sativa*), sugarcane (*Saccharum officinarum*), elephant grass (*Pennisetum*

purpureum), and lemongrass (*Cymbopogon ciratus*) as the research object that grew in Tegal Regency Central Java, Cirebon Regency West Java, Grobogan Regency, Central Java, and Pati Regency Central Java.

The tools used in this research were a camera, plant description equipment, and taxonomic affinity analysis software. The research method used was the taximetry method. The morphological characters observed were in the organs of leaves, stems, roots, flowers, and fruit. The observed morphological character data were compiled in the Microsoft Excel Matrix and scored. Furthermore, the scoring results were analyzed using the NTSys-PC version 2.02i program, and the final results were presented as a dendogram.

RESULTS AND DISCUSSION

We used five species in the Poaceae family, namely Corn (*Zea mays*), Rice (*Oryza sativa*), Sugarcane (*Saccharum officinarum*), Elephant grass (*Pennisetum purpureum*) and Lemongrass (*Cymbopogon citratus*) because Indonesian people quite often use these five species as food such as corn, rice, and sugarcane as well as wound healing in elephant grass and food ingredients in lemongrass. Differences in characters in the organs of roots, stems, leaves and flowers as shown in Figures 1, 2, 3 and 4.

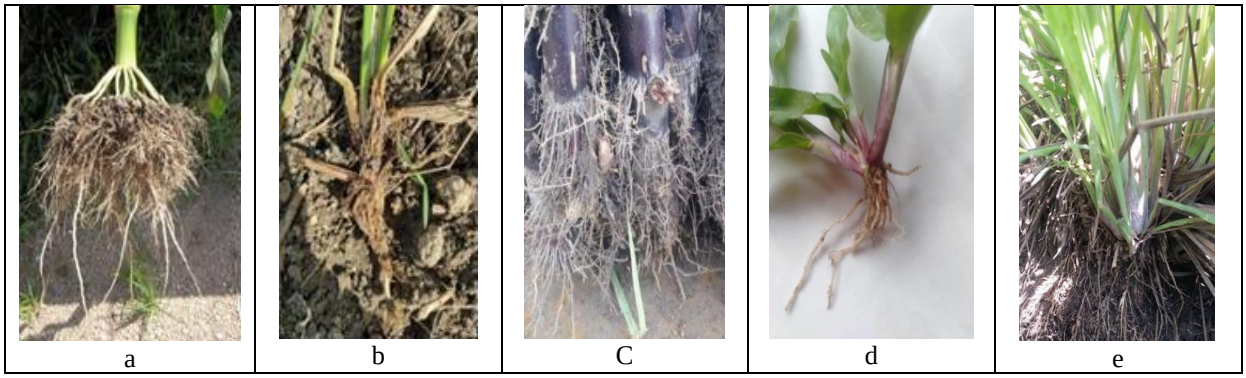

Figure 1. Root character. a. *Zea mays*; b. *Oryza sativa*; c. *Saccharum officinarum*; d. Pennisetum purpureum; e. Cymbopogon citratus

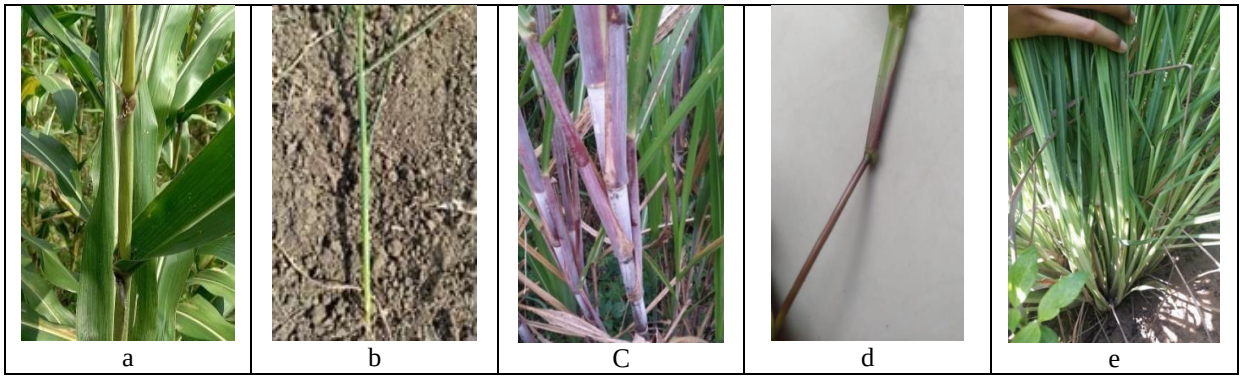

Figure 2. Stem character. a. *Zea mays*; b. *Oryza sativa*; c. *Saccharum officinarum*; d. Pennisetum purpureum; e. Cymbopogon citratus

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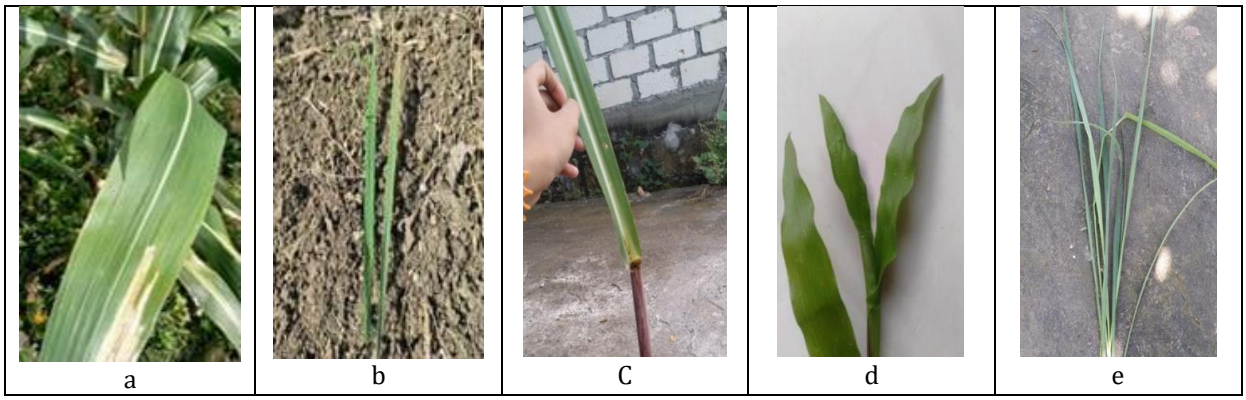

Figure 3. Leaves character. a. *Zea mays*; b. *Oryza sativa*; c. *Saccharum officinarum*; d. Pennisetum purpureum; e. Cymbopogon citratus

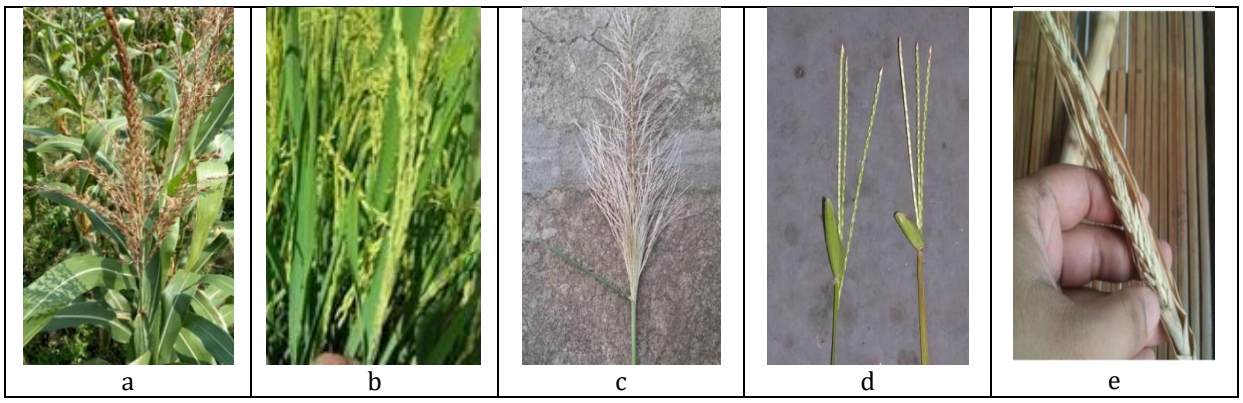

Figure 4. Flower character. a. *Zea mays*; b. *Oryza sativa*; c. *Saccharum officinarum*; d. Pennisetum purpureum; e. Cymbopogon citratus

Table 1. Morphological characters of Poaceae

No	Characters	Species				
		Zea mays	***Oryza sativa***	***Saccharum officinarum***	***Pennisetum purpureum***	***Cymbopogon citratus***
1.	Leaf base	Curvy	Curvy	Ragged	Curvy	Pointed
2.	Leaf margin	Flat	Flat	Flat	Smooth jagged	Flat
3.	Leaf colour	Green	Green	Light Green	Green	Green
4.	Petiole	Long	Short	Long	Short	Long
5.	Leaf length	100 cm	37-45 cm	145-166 cm	9 cm	79-105 cm
6.	Leaf width	5 cm	1,5-2 cm	4,5- 5 cm	2 cm	1,3- 1,5 cm
7.	Intervenium	Parchment-like	Parchment-like	Paper-like	Parchment-like	Parchment-like
8	Leaf ornamentation on the adaxial part	Coarse hair	Coarse hair	Coarse hair	Stiff hair	Coarse hair
9.	Leaf ornamentation on the abaxial part	Coarse hair	Coarse	Downy hair	Downy hair	Downy hair
10	Stem form	Cylindrical	Hollow and round	Ribbon-like	Erect and round	Cylindrical
11.	Stem surface	Slippery	Downy hair	Slippery	Covered in leaves	Slippery
12.	Stem colour	Green	Green	Yellowish green	Green mixed with brownish red	Green
13.	Stem height	150-180 cm	40-50 cm	195-200 cm	13 cm	26-37 cm

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No	Characters	Species				
		Zea mays	***Oryza sativa***	***Saccharum officinarum***	***Pennisetum purpureum***	***Cymbopogon citratus***
14.	Root architecture	Fibrous root	Fibrous root	Fibrous root	Fibrous root	Fibrous root
15.	Flower colour	Purplish red	White/Purple	Brownish white	Gold	White
16.	Fruit type	True fruit	True fruit	Fruitless	Fruitless	Fruitless
17.	Habitus	Shrub	Herbaceous	Shrub	Herbaceous	Herbaceous

Table 1 shows the description of morphological characters in Poaceae. The characters were scored and analyzed by using the NTSYS program. Based on the analysis of the relationship between 5 species in the Poaceae family using the NTSYS program, 17 morphological characters were found, which became the basis for determining the relationship, including leaf base, leaf margin, leaf colour, petiole, leaf length, leaf width, intervenium, leaf ornamentation of adaxial part, leaf ornamentation of abaxial part, stem form, stem surface, stem colour, stem height, root architecture, flower colour, fruit type, and habitus. From these characteristics, it is found that many differences and similarities are owned by each species so that the value of the existing similarity coefficient can be known. The higher the similarity coefficient value, the more related the species analyzed (Lukmanasari et al. 2020).

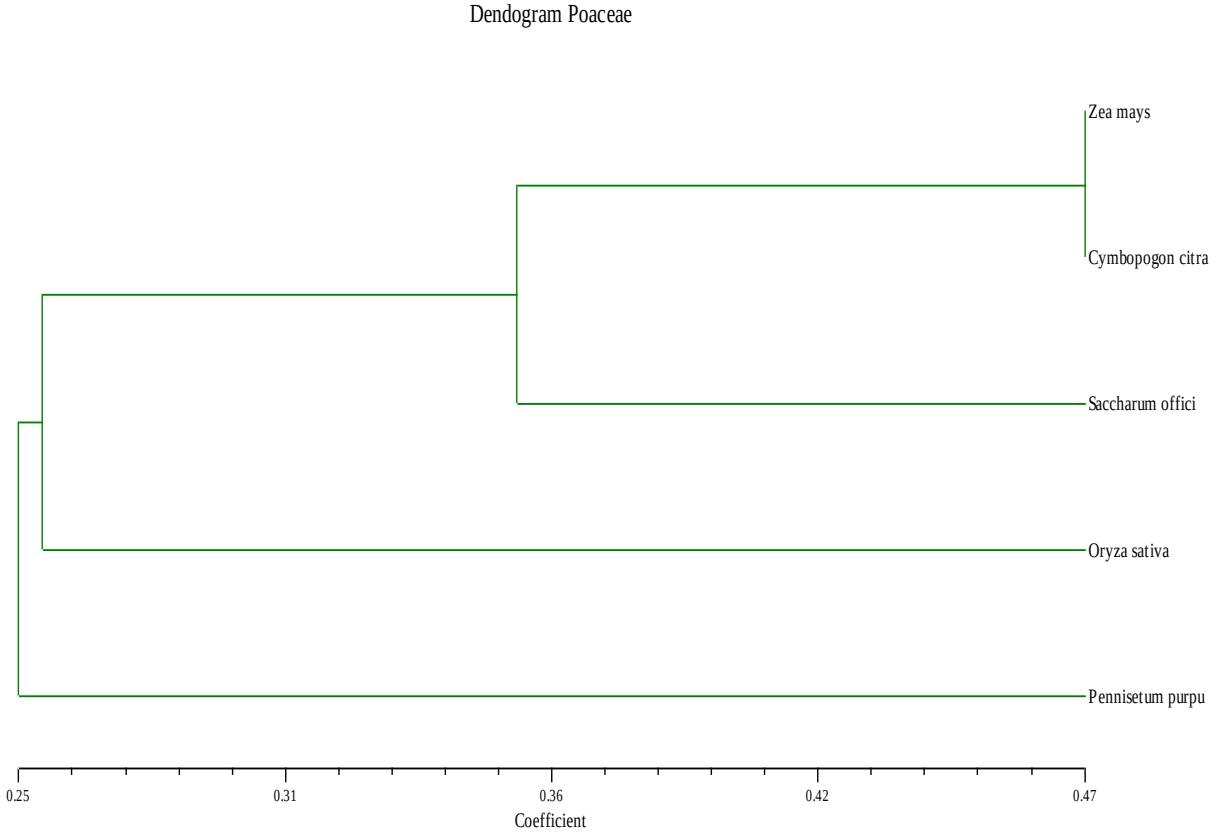

Figure 5. Poaceae Dendogram

The phenetic approach used in this research is based on an inequality index, pattern analysis, and diversity index (Agustiar et al. 2020). The dendogram (Figure 5) shows the existence of 2 large groups that divide five species of Poaceae members. Group A (first) consisted of species *Zea mays, Cymbopogon citratus, Saccharum officinarum* and *Oryza sativa*, while group B (second) was *Pennisetum purpureum*. *Zea mays* and *Cymbopogon citratus* have the closest kinship, which has a similarity

coefficient of 0.47. Table 1 shows similarities in the character of the leaf edges, leaf colour, petiole, intervenium, stem form, stem surface, stem colour, and root architecture. This follows the opinion of (Boon et al. 2008; Eltahir, A. S. and AbuEReish 2010) that the stem shape shared by these two plants is cylindrical.

The dendogram describes the similarity coefficient of *Zea mays* and *Cymbopogon citratus* with *Saccharum officinarum* of 0.35. Similar characters between the three species are leaf margin, petiole, stem surface, and root architecture. In addition, several characteristics in *Zea mays* and *Cymbopogon citratus* are different from *Saccharum officinarum*: leaf base, leaf colour, length, width, flesh, stem form, stem height, and flower colour. Mainly on the stem, sugarcane has a stem that is erect and has no branches. Sugarcane stalks can reach a height of 3 to 5 meters or more. Sugarcane plant also has green, dark red, purple bark or a combination of these colours (Ekpelikpeze et al. 2016).

From the dendogram, we can also observe that the taxonomic affinity among *Zea mays, Cymbopogon citratus* or *Saccharum officinarum* and *Oryza sativa* is quite far because it has a similarity coefficient value of 0.26. *Oryza sativa* has a stem quite different from the other three species, which is segmented and has a cavity in each segment (Vijay and Roy 2013). Meanwhile, the species that has the furthest taxonomic affinity with the other four species that form.

Their group is *Pennisetum purpureum*, with a similarity coefficient of 0.25. Many characteristics of this species differ from others, including leaf margins, length, width, leaf ornamentation of the adaxial part, stem form, stem surface, stem colour, stem height, flower colour, and habitus. The form of the stem of this plant is different from the others in that it is shaped like a ribbon. Besides that, there are other characteristics where a slightly hairy leaf shield covers the stem of this plant.

Cluster analysis shows that morphological characters are very important for clustering. According to (Ceolin and Miotto 2011), morphology is the main information source for identifying plant taxa. In (Sogbohossou and Achigan-Dako 2014) research using the Amaranthus genus, it can be seen that the 100 varieties are related based on morphological characteristics. Moreover, in (El-Raouf 2021) study using morphological and anatomical characteristics of leaves, it is possible to determine the taxonomic significance of the Aizoaceae family. In addition, (Paul and Chowdhury 2021) also suggested that foliar micromorphology could be an important key to the grouping of the Polygonaceae family. Although molecular techniques are currently also applied in determining taxonomic affinity, morphological characters remain relevant (Susandarini et al. 2013) because morphological characterization is the basic information for further DNA analysis. Based on the existing studies and this research, we can determine the taxonomic affinity of plants based on morphological characters, which are the basis for further analysis.

CONCLUSIONS AND SUGGESTIONS

The taxonomic affinity belonging to the Poaceae family can be seen from the general characteristics of the leaves, stems, roots, flowers and fruit. The dendogram shows that *Zea mays* and *Cymbopogon citratus* have the Closest taxonomic affinity. Furthermore, the research can be deepened by using other characteristics such as anatomy and genetics to clarify their taxonomic affinity status. It is also necessary to analyze the taxonomic affinity of other species. By knowing their relationship, we can see the potential for plant breeding that can be carried out to increase the richness of the germplasm.

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