



The Taxonomic Affinity of 7 members of Rutaceae Based on Morphological Characters

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ABSTRACT

This research aims to determine the taxonomic affinity of 7 members of Rutaceae based on morphological characters. There are 7 species observed namely *Aurantifolia swingle*, *Citrus hystrix*, and *Citrus maxima*, *Citrus limon*, *Murraya paniculate*, *Limonia acidissima*, and *Citrus paradisi*. We used 13 morphological characters including leaf surface, leaf tip, leaf base, leaf margin, flower color, crown shape, number of petals, rind, fruit shape, flesh of fruit's color, rind's color, fruit apex's shape, and stem surface. Analysis using NTSYS showed that *Aurantifolia swingle* and *Citrus paradisi* share the most widely characters in leaf surface, leaf tip, leaf base, leaf margin, flower color, number of petals, fruit shape, rind's color, and stem surface with a similarity coefficient is 0.69. This finding gives an insight that morphology still could be used in grouping species based on their similarity. We recommended to add more species in Rutaceae as well as increase the number of morphological characters to get a comprehensive data.

INTRODUCTION

Identification is an activity that aims to determine the correct name and its proper place in the classification system. This activity can be done by matching unknown plants with known plants found in libraries, herbariums, and living collections. The identification of a plant can be done through five methods e.g. key taxonomic methods, writing plant descriptions, comparing specimens, comparing pictures, and opinions from taxonomist (Pamungkas & Alamsyah, 2021). All morphological characters could be compared with pictures or descriptions on book. Identification of a plant species needs to be done to collect information about the diversity of the plant that can support the emergence of the expected genetic potential. Furthermore, through identification, we can relate the taxonomic affinity between plant species, one of which is by observing the similarities in their morphological characters. This

scope belongs to phenetic study classifying the species overall based on similarity in morphology or observable traits (Choudhuri, 2014).

Various studies on plant relationships based on morphological characters have been carried out on several species such as Apocynaceae (Agustiar et al., 2020; Rahmawati et al., 2016), Asteraceae (Wardani, 2019), and also in the genus *Knema* and *Myristica* (Arrijani, 2003), and the genus *Portulaca* (Prasgi et al., 2022). Plant parts that are often used as the basis for grouping include roots, stems, leaves, flowers, and fruits as well as other parts that are unique to the target species. In addition to these families, the Rutaceae family has also received the attention of researchers. Rutaceae is a plant family that has a very high diversity consisting of 162 genera and 2085 species (Groppo et al., 2022), one example being the *Citrus* genus with quite a lot of species members. However, only 3 groups of oranges were considered original, namely mandarin, big orange, and citron, while the others were the result of a cross between these three groups (Zufahmi & Nurlaila, 2018). Research on taxonomic affinity in Rutaceae as reported by (Appelhans & Wen, 2020) in the genus *Ivodea* (a member of the family Rutaceae) in Madagascar shows that it is phylogenetically closely related to the genus *Vipers* and is strongly supported by data that its ancestors came from Asia. (Groppo et al., 2022) explained that the Rutaceae was quite close to the Simaroubaceae and Meliaceae families but quite far from the Sapindaceae, Anacardiaceae and Burseraceae. *Citrus reticulata* with *Citrus ichangensis* in (Hynniewta et al., 2014) study has a fairly close genetic relationship. Meanwhile, Tegal lime has a close phylogenetic relationship with *Citrus aurantium* (Yumna Rahmadias Hanifa, Sri Pujiyanto, Rejeki Siti Ferniah, 2021).

Based on previous studies, research on taxonomic affinity in Rutaceae has been investigated at the genetic level, but affinity based on morphological characters actually cannot be ignored. Morphology can be the basis we use for classification and affinity, so this study was conducted to determine the relationship between Rutaceae in 7 species, namely *Aurantifolia swingle*, *Citrus hystrix*, and *Citrus maxima*, *Citrus limon*, *Muurraya paniculate*, *Limonia acidissima*, and *Citrus paradisi* based on morphological characters.

METHOD

Seven species of plant from the Rutaceae family were used including *Aurantifolia swingle*, *Citrus hystrix*, *Citrus maxima*, *Citrus limon*, *Muurraya paniculate*, *Limonia acidissima*, and *Citrus paradisi*. The research was conducted in May 2022 and located in Plumpung Village, Margomulyo District, Bojonegoro, East Java.

This study used a descriptive method with direct observation techniques through characterization and morphological documentation of species from the Rutaceae family. Plants were collected using random sampling. The morphological characters used are derived from the organs of stem, leaves, flowers, and fruit namely leaf surface, leaf tip, leaf base, leaf margin, flower color, crown shape, number of petals, rind, fruit shape, flesh of fruit's color, rind's color, fruit apex's shape, and stem surface. The data obtained were scored and computed in NTSYS software. UPGMA (Unweighted Pair Group Method with Arithmetic Mean) cluster analysis was used for grouping until the results were obtained in the form of a Rutaceae dendrogram.

RESULT AND DISCUSSION

We used 7 species of the family Rutaceae because these species grow in Indonesia and the description of their taxonomic affinity is not well known. The comparison of the morphological forms of the 7 species could be seen in Figure 1.



Figure 1. Description: a. *Aurantifolia swingle*; b. *Citrus hystrix*; c. *Citrus maxima*; d. *Citrus limon*; e. *Murraya paniculate*; f. *Limonia acidissima*; g. *Citrus paradisi*

Table 1 describes the morphological characters present in the organs of stems, leaves, flowers, and fruits of 7 species of Rutaceae which are the basis of taxonomic affinity. There are 13 characters used including leaf surface, leaf tip, leaf base, leaf margin, flower color, crown shape, number of petals, rind, fruit shape, flesh of fruit’s color, rind’s color, fruit apex’s shape, and stem surface. The characters used show the differences and similarities that form the basis for scoring these characters. The scoring results were then analyzed using NTSYS and the Rutaceae taxonomic affinity could be described using a dendrogram (Figure 2).

Table 1. Morphological Characters of Stem, Leaves, Flowers, and Fruits of Rutaceae

| No | Character | Species | | | | | | |
|----|--------------|-----------------------------|-----------------------|----------------------|---------------------|---------------------------|---------------------------|------------------------|
| | | <i>Aurantifolia swingle</i> | <i>Citrus hystrix</i> | <i>Citrus maxima</i> | <i>Citrus limon</i> | <i>Murraya paniculata</i> | <i>Limonia acidissima</i> | <i>Citrus paradisi</i> |
| 1 | Leaf surface | Smooth | Smooth | Waxy | Waxy | Waxy | Leathery | Smooth |
| 2 | Leaf tip | Blunt | Acute | Acute | Acute | Blunt | Blunt | Blunt |
| 3 | Leaf base | Rounded | Acute | Rounded | Rounded | Rounded | Acute | Rounded |
| 4 | Leaf margin | Crenatus | Lobatus | Entire | Entire | Entire | Entire | Crenatus |

| No | Character | Species | | | | | | |
|----|------------------------|-----------------------------|-----------------------|------------------------|---------------------|---------------------------|---------------------------|------------------------|
| | | <i>Aurantifolia swingle</i> | <i>Citrus hystrix</i> | <i>Citrus maxima</i> | <i>Citrus limon</i> | <i>Murraya paniculata</i> | <i>Limonia acidissima</i> | <i>Citrus paradisi</i> |
| 5 | Flower color | White | Redness - purplish | White | Green | White | Greenish white | White |
| 6 | Crown shape | Lancet | Star-liked | Lancet | Star-liked | Lancet | Lancet | Star-liked |
| 7 | Number of petals | 4 | 4 | 5 | 5 | 5 | 5 | 4 |
| 8 | Rind | Smooth | Thick and wrinkled | Thick and rough enough | Fleshy | Smooth | Hard scaly | Rough enough |
| 9 | Fruit shape | Round | Round | Round | Oval | Elongate | Round | Round |
| 10 | Flesh of fruit's color | Light green | Yellowish green | Pink | Reddish yellow | Reddish yellow | Brownish red | White |
| 11 | Rind's color | Dark green | Dark green | Dark green | Light yellow | Red | White Brown | Dark green |
| 12 | Fruit apex's shape | Rounded | Truncate | Rounded | Oval | Oval | Rounded | Truncate |
| 13 | Stem surface | Thorny | Thorny | Thorny | Thorny | Rough | Rough | Thorny |

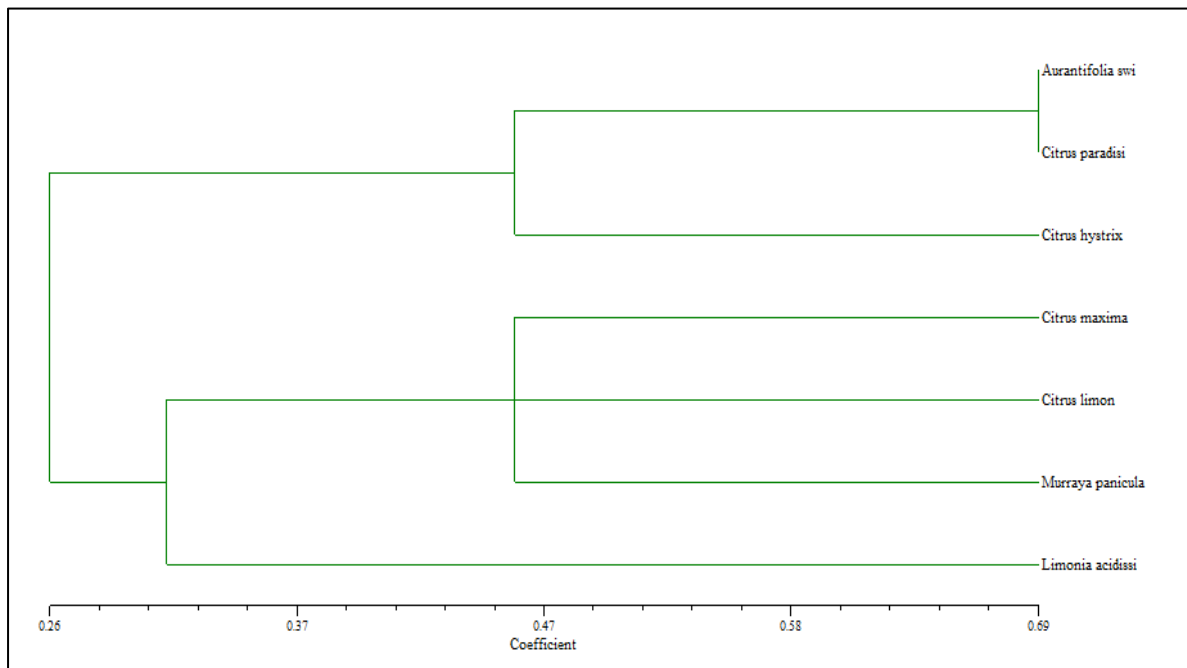


Figure 2. Rutaceae Dendrogram

Observable traits such as flower and fruit are possible to use to determine the group like (De Giorgi et al., 2022) research in Asteraceae. From the dendrogram, it can be concluded that the taxonomic affinity of 7 species of the family Rutaceae are divided into 2 major groups. The first group consisted of limes (*Aurantifolia swingle*), limes (*Citrus paradisi*), and kaffir limes (*Citrus hystrix*) but kaffir limes (*Citrus hystrix*) separated themselves from the two species with a coefficient scale of 0.47 because the three species had similar characteristics in the organs on the leaf surface, leaf tip, number of petals, fruit shape, rind's color, and stem surface. Meanwhile, lime (*Aurantifolia swingle*) and (*Citrus paradisi*) have a coefficient scale with a coefficient of 0.69 with a close relationship having leaf surface, leaf tip, leaf base, leaf

margin, flower color, number of petals, fruit shape, rind's color, and stem surface. The second group had 4 species with a similarity coefficient scale of 0.30 with similar characteristics of organs on the margin of the leaves and the number of petals. Furthermore, the Kiwis species (*Limonia acidissima*) separated itself from 3 species. The other three species, Grapefruit (*Citrus maxima*), Lemon (*Citrus limon*), and Kemuning (*Murraya paniculate*) have a taxonomic affinity with a coefficient scale of 0.47 with similarities in the leaf surface and leaf base.

The differences that exist will further separate the taxonomic affinity between species. The similarity coefficient that is closer to 0 indicates that the level of similarity between species is said to be far away, while the closer to 1 the level of similarity between species is getting closer. The dendrogram in Figure 2 shows the closest relationship between the species *Aurantifolia swingle* and *Citrus paradisi* because they have a similarity coefficient of 0.69. According to (Zufahmi & Nurlaila, 2018), the level of *similarity* is said to be far if it is less than 0.60% or 60. Based on this, the five other species besides *Aurantifolia swingle* and *Citrus paradisi* have a close relationship because the similarity coefficient of each group is less than 0.6.

Recently, the research shows that the classification of Rutaceae has been changed drastically (Appelhans, Wen, & Wagner, 2014). Based on phylogenetic study, the genera *Melicope*, *Acronychia*, and *Euodia* in Rutaceae family are not monophyletic in their current circumscriptions. (Appelhans, Wen, Wood, et al., 2014) also said that in the other research *Melicope* spp. (Rutaceae) were not monophyletic based on molecular phylogenetic. Nevertheless, morphological characters are one of the important data used as the basis for taxonomic affinity between species (Sungkawati et al., 2019) and it is easy to examination in this kind of study (Susandarini et al., 2013). As stated by (Viscosi & Cardini, 2011), leaf morphology plays an important role in plant systematic therefore we can classify the plants into suitable group. In *Begonia* (Permata & Susandarini, 2022), the leaf reinforcement character is one of the characters that can group 19 *Begonia* species into 3 clusters. Mulya also emphasized that the character of leaf shape, the color of the inside and outside of the rhizome, and the presence of trichomes were the characters that influenced the clustering of *Curcuma* spp. (Sungkawati et al., 2019). In line with this study, the vegetative and generative characters including canopy, stem, fruit leaves, and fruit calyces on *Diospyros* spp. showed a detailed dendrogram clustering (Rindyastuti et al., 2021). The use of different characters may affect the clustering of the dendrogram so that the more morphological characters used, the more detailed results will be obtained.

CONCLUSION

The results of morphological characterization in seven species of the family Rutaceae showed variations in leaf surface, leaf tip, leaf base, leaf margin, flower color, crown, petals, fruit skin, fruit shape, flesh color, skin color, apex shape, stem surface. The similarity coefficient of 0.69 consists of 1 group, namely Lime (*Aurantifolia swingle*) and Lime (*Citrus paradisi*) which confirms that these two species are the closest among other species. Meanwhile, the *similarity coefficient* value is 0.47, there are 2 groups. Group I consisted of

Aurantifolia swingle, limes (*Citrus paradisi*), and kaffir limes (*Citrus hystrix*). Group II consists of *Citrus maxima*, Lemon (*Citrus limon*), and Kemuning (*Murraya paniculate*).

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