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HABITAT CHARACTERISTICS OF MANGIFERA CASTURI KOSTERM. IN BANJAR DISTRICT OF SOUTH KALIMANTAN, INDONESIA

Gunawan*, **Muhamat**, Researchers
Fadhila Siti, **Farida Olivia Ana**, Students
Department of Biology, Faculty of Mathematics and Natural Sciences,
University of Lambung Mangkurat, South Kalimantan, Indonesia
*E-mail: gunawan@ulm.ac.id

ABSTRACT
Banjar is one of the districts in South Kalimantan that is rich in *Mangifera* germplasm. One of the endemic mango species is *Mangifera casturi*. This study aims to obtain information about habitat, distribution, and the most influential environmental that affect the existence of *M. casturi* in Banjar Districts. The data collection was done by survey and purposive sampling method. The ecological data were analyzed using PCA (*Principal Component Analysis*) generated from Minitab 16 software to determine the most influential environmental factor affecting the existence of *M. casturi* in Banjar Districts. The results showed that *M. casturi* is at an altitude (35-109 masl), air temperature (27,9 – 33,1 °C), humidity (64,3 - 86,9 %), light intensity (19.442 – 96.938 lux), soil temperature (27,1 - 32,8 ˚C), soil moisture (40,6 – 77,2 %), and soil pH (5,4 – 6,8). The most influential environmental factor affected the existence of *M. casturi* in Banjar Districts is air temperature with an eigenvalue of 0,524 (PC1). The most common locations for *M. casturi* in Banjar Districts were consecutively Astambul (40%), Mataraman (20%), Karang Intan (11.43%), Beruntung Baru (8.57%), East Martapura (8.57 %), West Martapura (5.71%), and Gambut (5.71%).

KEY WORDS
Mangifera casturi, PCA, microhabitat, conservation.

Mangifera is one of the most important genera of Anacardiaceae which is a plant family that produces much commercial fruit in the world (Fitmawati et al., 2016). Mangifera in Indonesia is found in several areas including the islands of Kalimantan, Sumatra, and Sulawesi (Polosakan, 2016). Mangifera occupies the second position after bananas among tropical fruits known as fruits with great taste, color, and variety (Singh, 2016).

Kalimantan is an island rich in Mangifera germplasm. Kalimantan has 31 species of Mangifera and 3 of them are endemic (Darmawan, 2018). According to Uji (2007), these endemic species include *M. casturi*, *M. Pajang,* and *M. havillandii*. *Mangifera casturi* is a mango species endemic to Borneo with fragrant fruit and sweet taste. M. casturi fruit size is small, and the color is from yellow-orange to purple-black. The existence of *M. casturi* as an endemic species has made it the identity flora mascot of South Kalimantan Province (Polosakan, 2016). *Mangifera casturi* fruit is very liked by the people of South Kalimantan so when it is fruiting, this fruit sells very quickly in the market.

Mangifera casturi has been listed as a plant with Extinct in the Wild status or extinct in the wild by the IUCN Redlist since 1998. The extinction of this species is caused by the destruction of its natural habitat, namely the forest (Polosakan, 2016). Its population in nature is decreasing with increasing land clearing into residential and plantation areas (Sari, 2008). The extinction of *M. casturi* needs to be avoided so that its potential can still be utilized and developed wisely for the benefit of various fields of life such as food, medicine, and a source of germplasm. Good management will protect the remaining *M. casturi* from the threat of human intervention and major climate change.

The most common use of *M. casturi* is for public consumption. Other uses of M. casturi are still very rare, even though this plant has the potential a traditional medicine. Mangifera has been widely used as traditional medicine, among others, to treat diabetes, diarrhea, dysentery, rheumatism, high blood pressure, and various skin diseases (Parvez, 2016).

Utami (2020) stated that *M. casturi* fruit has been tested as an anti-inflammatory herbal medicine. *M. casturi* also contains antioxidants in the leaves (Bakti et al., 2017; Sutomo, Azhari, et al., 2017) and bark (Ramadhan et al., 2021). *M. casturi* also has antibacterial properties (Rosyidah et al., 2010).

Distribution information is very important in plant species because over time the habitat of these species is influenced by anthropogenic activities and natural factors (Zarechahouki & Javad, 2015). Habitat quantity and quality have a significant influence on the distribution and species richness. Information on habitat and distribution will produce predictions for the conservation of individual species (Purves & Dushoff, 2005). According to Zarechahouki & Sahragard (2016), information about the impact of environmental factors is important to know because it can describe the distribution of vegetation, make habitat spatial models, and assist in planning the habitat management of these species.

The existence of *M. casturi* is increasingly threatened due to the conversion of land into agricultural land or settlements by local communities. Many *M. casturi* trees have died and fallen trees due to extreme winds in the rainy season, so it is estimated that the number of *M. casturi* will continue to decrease. One of the efforts to conserve *M. casturi* is to provide information on the distribution and the most influential environmental factors. These data can be used for the development and conservation of *M. casturi* in the future. This study is the first to reveal environmental factors and distribution for *M. casturi* in Banjar Districts.

MATERIALS AND METHOD OF RESEARCH

Sampling was conducted in Banjar districts in South Kalimantan. The geographic scope of this study includes the area of approximately 2^{o} 49' 55” – 3^{o} 43' 38” and 114^{o} 30' 20” - 115^{o} 35' 37”. Authors collected the occurrence data based on information from local communities and forestry service. Explorative field surveys using a method from Rugayah et al. (2004). The field study period was from May to August 2022. Plant sample were collected and herbarium specimens were deposit in Biosystematics laboratory of University of Lambung Mangkurat, South Kalimantan.

Measurement of environmental factors includes altitude, air temperature, humidity, light intensity, soil temperature, soil moisture, and soil pH. Measurement of environmental factors was carried out in the morning (06.00 – 08.30), afternoon (12.00 – 14.30), and afternoon (15.00 -17.30) and was repeated for 3 different days for tree sample. Coordinate of *M. casturi* was recorded by GPS Garmin 76CS. Light intensity was determined using *digital lux meter* AS803.

Table 1 – Environmental factor around *M. casturi*

Environmental Factor		Unit	Tools
Climatic factor	• Light intensity	Lux (lx)	Digital lux meter
	• Temperature	Celcius (°C)	Digital Thermohygrometer
	• Air humidity	Persen (%)	
Edafic factor	• Soil temperature	Celcius (°C)	Digital soil tester
	• Soil humidity	Persen (%)	
	• Soil pH t		
Topografic factor	• Altitude	Above sea level (asl)	

Specimens obtained from the field were transferred to new newsprint, arranged and pressed in a bag, then dried in an oven for 2-3 days at a temperature of 50-60°C. The dried specimens were arranged on acid-free herbarium plaque paper measuring (43x30) cm2, then mounted on the specimen. Placing the specimens was done by sewing the stems/fruits or using 3M tape, then the herbarium label was affixed to the bottom right of the plaque paper with a distance of 0.5 cm from the edge (Djarwaningsih 2002).

The ecological data from field surveys that has been obtained are then analyzed using PCA (Principal Component Analysis) or Main Component Analysis to determine the environmental factors that have the most influence on Mangifera casturi using the Minitab 16 version.

Figure 1 – Fruit of *Mangifera casturi*

RESULTS AND DISCUSSION

The results showed that the *M. casturi* in Banjar Districts was spread over 35 villages in 7 sub-districts. The presence of *M. casturi* is at various altitudes, between 35 to 109 m asl. *Mangifera casturi* in the yard of the house and cultivated land. Based on information from the local community, it was found that most of the *M. casturi* trees were inherited from the owner's parents. The presence of *M. casturi* in the yard of the house can provide shade and coolness because the large tree canopy can block the heat of the sun entering the yard.

Mangifera casturi is also deliberately planted on the banks of the river to avoid river abrasion. This is in accordance with Darmawan (2018) that the environment for growing musk plants comes from the residents' yards and fields.

The measurement results of environmental parameters obtained in the field were analyzed using PCA (Principal Component Analysis). PCA was performed to determine environmental factors or environmental variables that influenced the presence of *M. casturi*. Johnson & Wichern (2007) principal component analysis is a statistical technique for converting most of the original, correlated variables into a new set of smaller, independent variables. This analysis is useful for reducing data, making it easier to interpret the data. The variables used in this study consisted of variables from climatic factors (light intensity, air temperature, and humidity), and edaphic (soil temperature, soil moisture, and pH). soil), and topography (altitude) which is then used as the independent variable (X), while the dependent variable (Y) is the discovery of *M. casturi*.

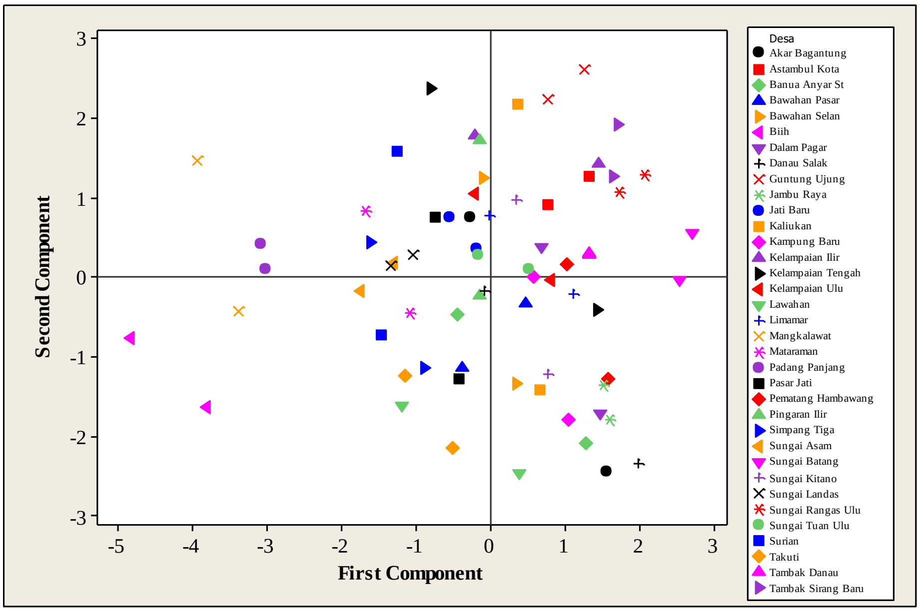

Figure 2 – Score Plot of *M. casturi*

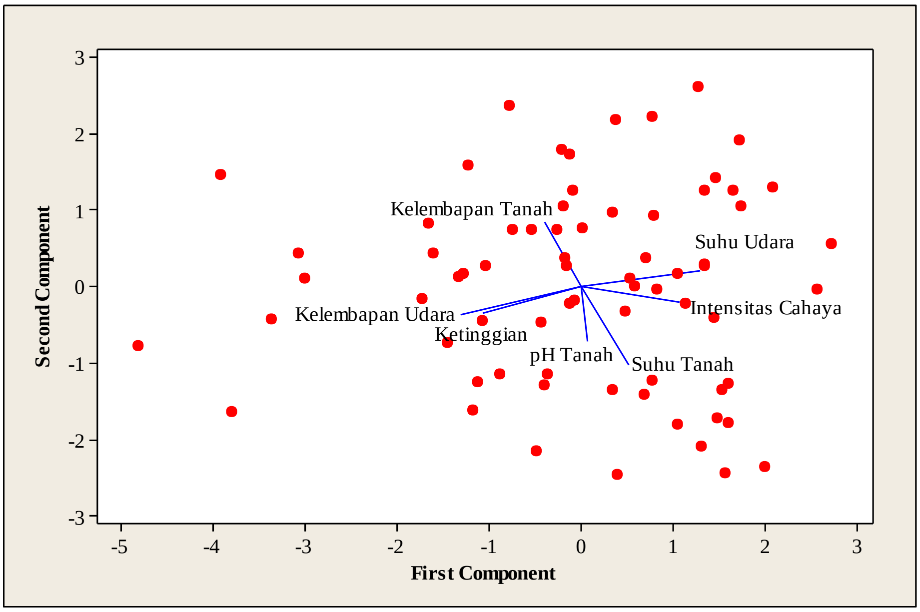

Figure 3 – Biplot of M. casturi

Based on the PCA results, shows that the seven new components can explain 100% (the first component is 35.3%, the second component is 23.1%, the third component is 14.3%, the fourth component is 9.7%, the fifth component is 7,1%, the sixth component of 6.1%, and the seventh component of 4.4%) of the overall variability of the observed factor variables. This indicates that the first component factor provides relatively greater information than the other component factors regarding the environmental conditions of the *M. casturi* habitat. The first component shows a greater value than the other components, but all components also provide information in describing and explaining the habitat conditions of *M. casturi*. The cumulative value shows a combination of proportions or component quantities that can represent the variance of all original variables. PCA results show the total value of diversity described by components 1 to 7, which is 100% of the observed environmental variables. This means that the components of environmental factors greatly affect the presence of *M. casturi.*

Based on the results of the analysis, there are three main components (PC / principal component) and these are the dominant environmental factors that contribute to the presence of M. casturi in Banjar Districts. The eigenvalues that are more than 1 have three main components, namely 2.4694; 1.6160; and 1.0004 then one main component is taken which is already representative which is 2.4694 with a cumulative value of 0.353 so that one principal component (PC) can explain about 35.3% of the diversity of the original data. The influence between one variable and another can be seen in the Score Plot and Biplot graphs. The Score Plot graph depicts the distribution of M. casturi in various locations in Banjar Districts. The Biplot graph illustrates the relationship between environmental factors that influence the presence of *M. casturi*. Score Plot and Biplot PCA results are presented in Figures 2-3.

Principal component analysis will produce output in the form of eigenvalues. Eigenvalue is the relative importance of each factor in calculating the analyzed variables (Santoso, 2002). Eigenvalues are always sorted from largest to smallest with the criteria that the cumulative value is the number of factors formed and eigenvalues below one (1) are not used to calculate the number of factors formed (Young & Pearce, 2013). Umar (2009) if the total eigenvalue has a value of less than one (1) indicates that the factor cannot explain the variable well.

Biplot is an image of graphs and nxp matrices and refers to two types of information contained in matrix data (Beh, 2012). Biplot analysis shows that the variables are depicted as directed lines. Two variables that have a positive correlation value will be depicted as two straight lines or form a narrow angle, two variables with a negative correlation value will be depicted in the form of two opposite lines or form a wide angle (blunt), and two uncorrelated variables will be described in the form of two lines with angles close to 90˚ (right) (Caraka & Tahmid, 2019).

The influence of several environmental factors on the presence of *M. casturi* in Banjar Districts is close and positive. Two main components consisting of PC1 and PC2 each have variables that affect the presence of *M. casturi* in Banjar Districts. These variables are air temperature (PC1) with an eigenvalue of 0.524 and soil moisture with an eigenvalue of 0.516 (PC2). Air temperature is positively correlated with light intensity indicated by a narrow angled line and negatively correlated with air humidity is indicated by a line in the opposite direction. Air temperature is not correlated with soil pH indicated by the shape of the line close to 90˚ (right-angled). Soil moisture is negatively correlated with soil temperature indicated by a line in the opposite direction.

The most influential environmental factor on the presence of *M. casturi* based on the analysis of the main components, namely air temperature with an eigenvalue of 0.524 in the first component (PC1). According to Makhmale et al. (2015) temperature affects the presence of Mangifera such as flowering. Cool temperatures of 15 C day/10 C night can induce flowering in the subtropics. Flowering can also be affected by cold temperatures in the tropical highlands. The timing of reproductive shoot initiation varies between cultivars. Very high and very low temperatures during flowering are harmful to pollen and trees fail to flower (Makhmale et al., 2015).

*Mangifera ca*sturi trees were found in several sub-districts in Banjar Districts. Each district has a different height. *Mangifera casturi* was found at the lowest altitude of 35 masl in Tambak Sirang Baru Village, Gambut District and the highest at 109 masl in Biih Village, Karang Intan District (Appendix 2). This is in accordance with Ramadani & Istiqomah (2017) which explains that the ideal topography for Mangifera is below 300 masl.

The altitude of the place is included in the physiographic factor. Altitude affects climate, especially rainfall and air temperature. Nurnasari & Djumali (2010) explained that the altitude of a place affects the air temperature and light intensity. The higher the place to grow, the lower the air temperature and the intensity of light received by plants, thereby inhibiting growth because the photosynthesis process is disrupted. Areas with low elevations have relatively higher concentrations of carbon dioxide (CO2) than areas with higher elevations.

The altitude determines the air temperature. The higher the location of a place, the air temperature and air pressure decrease while the rainfall increases. The lowlands will have a higher ambient temperature and air pressure than the highlands. Rainfall in the lowlands will also be lower than in the highlands (Handoko, 2017). High air temperature results in high evaporation, so the air humidity becomes low. Air humidity will affect plant flowering (Nurnasari & Djumali, 2010). Air temperature has a relationship with rainfall and humidity. High rainfall results in low temperature values and high humidity values. High rainfall will interfere with the flowering process. Continuous rain will damage the pollen and stigma of mango plants and cause pollination to fail. This means that fertilization and harvesting also fail (Triani & Ariffin, 2019).

The measurement results around *M. casturi* show that the average air temperature ranges from 27.9 - 33.1 C and the average humidity ranges from 64.3 - 86.9%. Measurement data in the form of air temperature and humidity were also compared with BMKG (climate agency) climate data in Banjar Districts during the data collection period. The air temperature measured is higher than the average air temperature from the BMKG because the measurements are taken from the morning, afternoon, and evening, while the BMKG data is an average of 24 hours. This also causes the measured air humidity to be lower than the average air humidity from the BMKG. This is similar to Suwardike et al. (2018) which states that the ideal average air temperature for mango plants ranges from 25 – 32 C and the average humidity reaches 87%. Bally (2006) explains that temperature has a direct effect on the growth rate of mango trees and fruit. The leaf rinsing cycle takes about 20 weeks when grown below 20 C day and 15 C night. Time will be more effective 6 weeks when it is below 30 C day and 25 C night. The time it takes for fruit to reach maturity is also affected by temperature. High temperature and low humidity reduce the photosynthetic efficiency of mango and increase respiration. This reduces the accumulation of low carbon and reduces the tree's ability to withstand harvest loads.

The light intensity around *M. casturi* is 19442 - 96938 lux . Suwardike et al. (2018) explained that solar radiation reached 73%. Light intensity is influenced by vegetation cover factor. Light can directly affect plant growth. Mutaqin et al. (2016) explained that too much light intensity can reduce levels of the hormone auxin in the leaves, causing the leaves to grow smaller. This causes the leaf area to be wider in places with low light intensity compared to places with high light intensity. Ramadani & Istiqomah (2017) added that the effect of light increases the work of enzymes in the formation of chlorophyll.

The soil temperature around *M. casturi* based on measurements was 27.1 - 32.8 C and soil moisture ranged from 40.6 - 77.2%. Mangifera casturi is generally found in dry land and tidal swamp land, but is most commonly found in dry land. According to Suwardike et al. (2018) mangoes grow more fertile in wet climates with a dry season of less than 3 months each year, but produce less fruit than in dry climates. Plants will also be susceptible to blendok disease and shoot dead and the fruit is a bit sour. Ramadani & Istiqomah (2017) added that this plant requires moderate soil fertility and moderate drainage, it can be planted on slopes with a slope of 8%. Soil temperature and soil moisture factors per sub-district for M. casturi in Banjar Districts can be seen in Figures 9 & 10.

High humidity can be caused by high rainfall. Heavy rainfall causes large amounts of water that fall to the ground. Nurnasari & Djumali (2010) explained that the need for adequate water will increase the rate of photosynthesis as a carbohydrate synthesis process, this will increase the rate of leaf growth. Ramadani & Istiqomah (2017) stated that rainfall and soil texture are related to the amount of water availability in the soil. Nutrient and mineral requirements for plants are obtained through absorption by roots along with water absorption.

The pH of the soil around *M. casturi* is 5.4 - 6.8. This is in accordance with Bally (2006) which states that the optimal pH range for mango growth is 5.5-7.5 with a low pH (acidic) being the most damaging to growth. Mango plants are tolerant of a wide range of soils from alkaline, calcareous soils to heavy clays. It produces best on sandy or gravel soils as it dries quickly after the rainy season.

CONCLUSION

Mangifera casturi in Banjar Districts is located at an altitude of 35 - 109 meters above sea level. Environmental factors around M. casturi are air temperature (27.9 - 33.1 C), air humidity (64.3 - 86.9 %), light intensity (19.442 – 96.938 lux), soil temperature (27.1 - 32.8 C), soil moisture (40.6 – 77.2 %), and soil pH (5.4 – 6.8). The most influential environmental factor on the presence of M. casturi based on the analysis of the main components, namely air temperature with an eigenvalue of 0.524 in the first component (PC1). Mangifera casturi in Banjar Districts is spread over 7 sub-districts, namely Astambul, Bauntung Baru, Gambut, Karang Intan, West Martapura, East Martapura, and Mataraman with the largest population in Astambul District with a percentage of 40%.

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