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CHARACTERISTICS OF THE CHEMICAL PROPERTIES OF SOIL UNDER ULIN (*EUSIDEROXYLON ZWAGERI*) AND MERANTI (SHOREA SP) TREE CROPS IN THE SEMPAJA ARBORETUM FOREST AT GENERAL TESTING CENTER FOR ENVIRONMENTAL INSTRUMENTS IN SAMARINDA

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ABSTRACT

The aim of this study was to determine the chemical and textural characteristics of the soil under Ulin (*Eusideroxylon zwageri*) and Meranti (*Shorea* sp) stands in the Sempaja Arboretum Forest, Samarinda Center for Standard Testing of Environmental Instruments.

This research was carried out from March – May 2022 at the Sempaja Arboretum covering an area of 2.5 ha which is located in the area of the Samarinda Center for Standard Testing of Environmental Instruments.

The research activities carried out included: literature study, field observation, preparation, determination of sampling points, field sampling, soil analysis in the laboratory, interpretation of soil analysis results and reporting.

The results showed that: (1) the chemical characteristics of the soil under ironwood stands were: soil pH (very acid), organic-C content (very low), total-N content (very low), available-P content (medium to high), cation content of Ca^{++}, $K^{+}$and Na^{+}base cations (very low to low), cation Mg++ (low to medium), CEC and saturation (low), texture class of silty loam soil; and (2) chemical characteristics of the soil under meranti stands, namely: soil pH (very acid), C-organic content (very low to low), content N-total (moderate), available-P content (moderate to very high), cation content of Ca^{++}, $K^{+}$and Na^{+}basic cations (very low to low), cation of Mg++ (low to moderate), CEC (low), base saturation (very low to low), silty loam soil texture class.

KEYWORDS

Soil Chemical Properties, Ulin Tree Crop, Meranti Tree Crop.

INTRODUCTION

The forest is a plant community that is dominated by trees and has environmental conditions that are different from those outside the forest. The environment is a complex system in which various factors mutually influence each other and the plant community (Soerianegara and Indrawan 1988).

As stated in the Law of the Republic of Indonesia Number 41 of 1999 that forest is an ecosystem unit in the form of a stretch of land containing biological natural resources dominated by trees in their natural environment, which cannot be separated from one another (Department of Forestry, 1999). Forest is an animal (animal) natural resource consisting of vegetable natural resources (plants) which together with the surrounding non-biological elements as a whole form an ecosystem.

High secondary or natural forest deforestation has negative implications for reducing the potential and distribution of shorea and ironwood in natural forests. This illustrates that shorea and ironwood stands are increasingly rare in natural forests. To increase its potential and distribution, cultivation and conservation efforts are needed through the development of plantation forests to avoid extinction (Wahyudi, Sari, and Saridan, 2014).

Soil as a medium for plant growth as a surface layer of the earth that functions as a place for growth and development of roots as a support for upright plant growth, as a habitat for organisms that actively participate in providing nutrients for plants as well as a supplier of water and nutrients or nutrients can integrally support soil productivity. So that it can produce optimal production (Hanafiah, 2012).

Soil chemical properties are defined as the overall chemical reactions that take place between soil constituents and between soil constituents and materials added in the form of fertilizers or other soil conditioners. The chemical properties of the soil are soil pH, C-organic, N-total, P-available, K -availability, base cations, cation exchange capacity, base saturation, aluminum saturation and texture (Sutanto, 2005).

To support the development of ironwood and meranti plantations, it is necessary to know the physical and chemical properties of the soil in their habitat. According to Junaidi (2012) that soil has a very important role in the growth of forest plants, because soil has varying physical and chemical properties that affect the availability of various kinds of macro and micro nutrient elements that are needed by plants. In a good metabolic process for maximum plant growth, proper physical and chemical properties are needed. Therefore, in the development of ironwood and meranti plantations, it is necessary to carry out environmental manipulation and appropriate silvicultural practices so that the growth of shorea and ironwood stands is maximized. For the domestication of a species, it is necessary to know the characteristics of the natural habitat in order to successfully develop plantation forests. Failure in species development in plantation forests due to inaccuracy in paying attention to the characteristics of the place where it grows. Therefore, it is necessary to conduct research to determine the chemical and textural characteristics of the soil where ironwood and meranti grow in their habitat in order to support development.

There is a need for research on the chemical and textural characteristics of the soil in the Sempaja Arboretum Forest, Center for Testing Standards for Environmental Instruments in Samarinda, so that the location can become a tool to prove the theory that the growing environment can affect vegetation by looking at the relationship between variations in soil physical and chemical properties. towards the ironwood and meranti trees on it.

The aim of this study was to determine the chemical and textural characteristics of the soil under Ulin (*Eusideroxylon zwageri*) and Meranti (*Shorea* sp) stands in the Sempaja Arboretum Forest, Samarinda Center for Environmental Instrument Standard Testing.

RESEARCH METHODS

A. Time and Place

This research was carried out from March – May 2022 at the Sempaja Arboretum which is located in the area of the Samarinda Center for Standard Testing of Environmental Instruments. The area of the Sempaja Arboretum is 2.5 ha.

B. Tools and Materials

The materials studied were soil samples to represent each type of soil planted by Meranti stands and Ulin stands in the Sempaja Arboretum Area.

The tools used are: soil sample ring, small hoe, plastic bag clip, post it to provide sample information, camera and stationery.

C. Research Activities

The research activities carried out included: literature study, field observation, preparation, determination of sampling points, field sampling, soil analysis in the laboratory, interpretation of soil analysis results and reporting.

D. Soil Sampling and Analysis

Sampling of soil as many as 3 points each on the type of soil overgrown with ironwood and meranti trees.As a control for the level of soil fertility with soil samples taken taking into account the suitability of the observed sample population. Furthermore, the 6 soil samples were brought to the Laboratory of Soil Science and Forest Nutrition, Mulawarman University, Samarinda for analysis.

E. Data Collection

Data collection consists of:

1. Primary data is data collection from field observations, and data from soil analysis in the laboratory which includes: soil pH; C-organic; N-total; P-available; K- available; exchangeable basic cations (Ca^{++}, Mg^{+}. K^{+}. Na^{+}); cation exchange capacity, base saturation, and soil texture.
2. Secondary data is data taken from the literature and the results of interviews with local people regarding the names of plant species, climate, topography, soil, other supporting data.

RESULTS AND DISCUSSION

A. Overview of Research Locations

The Sempaja Arboretum is located within the Dipterocarpa Research Center complex which is located on Jalan A. Wahab Sjachrani Sempaja Samarinda with an area of ± 2.5 Ha, geographically this area is located on 00º 27' 11,4"North Latitude (N) and 117º08'46,8"East Longitude (BT), (Abduracham,2003).

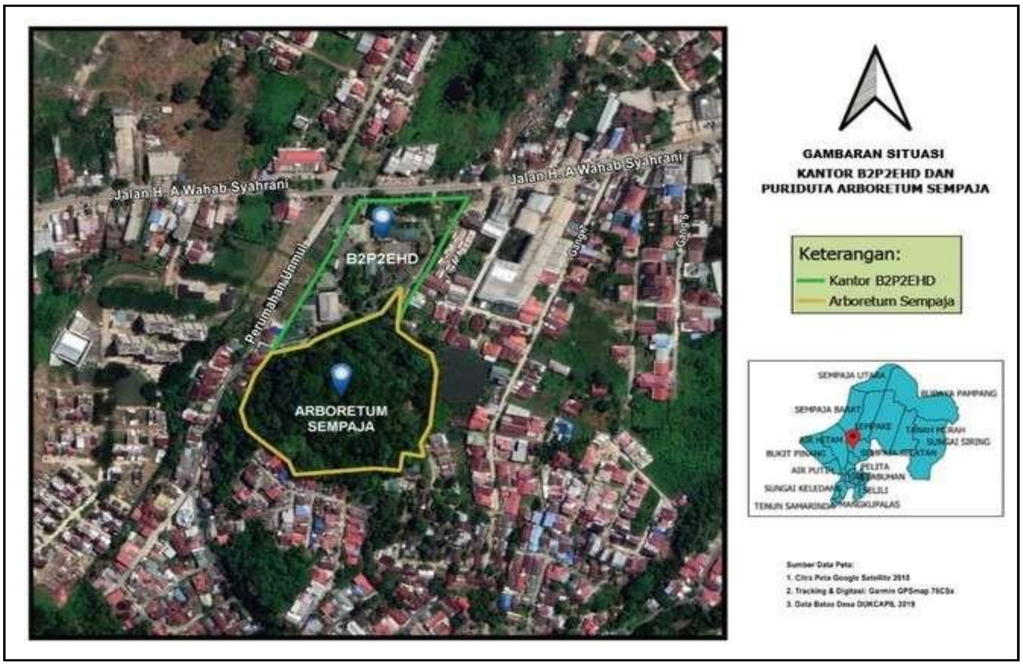

Figure 1. Description of the Sempaja Arboretum Research Location

In general, the average rainfall for the Samarinda region and its surroundings in 2020 ranges from 2200-2500 mm/year, the average monthly rainfall reaches 183 mm and the average rainy day is around 14 days per month. The highest rainfall occurs in January, which is 273 mm with 22 rainy days for 1 month, while the lowest rainfall occurs in September, which is 92 mm with 8 rainy days for a month.

The topography of the study sites varies, ranging from flat, gently sloping to slightly wavy to heavy (rather steep) with a slope of 2-8% to 16-25%, the altitude of the study site ranges from 94-148.30 meters above sea level.

Based on the land system, the soil type in the area around the study site is dominated by Kandik Podzolic, Kromic Podzolic and District Kambisol; undulating plain hilly physiography, Lithology of limestone. Based on geological formations including the Balikpapan formation, where sandstone and clay are interspersed with silt, shale, limestone and coal inserts. Quartz sandstone layer 1-3 m thick, brown shale, thin layer and sandy limestone. This shows the age of the lower Late Miocene - upper Middle Miocene. The depositional environment of the delta plains is 1,000-1,500 m thick.

Based on the inventory results in 2018, the Sempaja Arboretum has 1779 trees consisting of 75 types/species from 45 genera in 26 families. Gaharu-producing species were the most commonly found species, namely as many as 643 trees from each tree family in the Sempaja Arboretum area based on measurement data. Tree species from the Thymelaceae and Lamiaceae families/tribes have a large number of trees. However, from the number of species, the Dipterocarpaceae and Fabaceae families are more numerous. The Sempaja Arboretum has collected 6 of the 9 Dipterocarpaceae genera in Indonesia. These genera include Dipterocarpus, Dryobalanops, Hopea, Parashorea, Shorea, and Vatica. Of the six genera, the Shorea genus has the highest number of species, namely 22 tree species. Based on the number of trees, the type that is most often found is*AquilariaBeccarianaTiegh*,namely 540 trees, Shorea sp as many as 186 trees and *Dryobalanops*spas many as 106 trees.

B. Laboratory Analysis Results

The results of soil analysis at the location of ironwood stands at slopes of 18°, 24° and 30° are presented in Table 1.

Table 1. Results of Chemical and Textural Analysis of Ulin Stand Locations

No 1	Soil Chemical Properties	Land Slope		
		18°	24°	30°
1	Soil pH	4,18 (VA)	4,39 (VA)	4,21 (VA)
2	C-Organic (%)	0,75 (VL)	0,32 (VL)	0,37 (VL)
3	N-Total (%)	0,19 (L)	0,17 (L	0,20 (L
4	P-Available (ppm)	28,53 (M)	52,72 (H)	35,16 (H)
5	Ca^{++} (me/100 g soil)	0,88 (VL)	0,58 (VL)	0,48 (VL)
6	Mg^{++}(me/100 g soil)	0,68 (L)	1,08 (M)	1,32 (M)
7	K^{+}(me/100 g soil)	0,22 (L)	0,35 (L	0,23 (L)
8	Na^{+}(me/100 g soil)	0,10 (L)	0,11 (L)	0,08 (L)
9	KTK (me/100 g soil)	5,71 (L)	7,83 (L)	5,80 (L)
10	BaseSaturation (%)	32,89 (L)	27,10 (L)	34,46 (L)
11	Percentage Soil Fraction	Soil Texture		
	Sand (%) Silt(%) Clay (%)	34,86 57,38 7,76	32,12 53,82 14,06	40,59 52,17 7,24
	Texture Class	Silty Loam	Silty Loam	Silty Loam

Source: Results of Analysis of Laboratory of Soil Science and Forest Nutrition, University of Mulawarman, Samarinda(2022).

Information :VA = very acidic, VL = very low, L = low, M = moderate, H = high,

VH = very high

The results of soil analysis at the location of the meranti stands at slopes of 19º, 22º and 26º are presented in Table 2.

Table 2. Results of Chemical and Textural Analysis of Meranti Stand Locations

No	Soil Chemical Properties	Land Slope		
		19º	22º	26º
1	Soil pH	4,35 (VA)	4,44 (VA)	4,51 (VA)
2	C-Organic (%)	1,27 (L)	1,11 (L)	0,77 (VL)
3	N-Total (%)	0,27 (M)	0,30 (M)	0,27 (M)
4	P-Available (ppm)	25,01 (M)	69,50 (VH)	27,36 (H)
5	Ca^{++} (me/100 g soil)	0,98 (VL)	0,88 (VL)	1,27 (VL)
6	Mg^{++}(me/100 g soil	1,52 (M)	0,48(L)	0,62 (L)
7	K^{+}(me/100 g soil	0,28 (L)	0,18 (L)	0,22 (L)
8	Na^{+}(me/100 g soil)	0,17 (L)	0,19 (L)	0,18 (L)
9	KTK (me/100 g soil	8,39 (L)	9,08 (L)	8,63 (L)
10	BaseSaturation (%)	35,08 (L)	18,98 (VL)	26,51 (L)
11	PercentageSoil Fraction	Soil Texture		
	Sand (%) Silt (%) Clay (%)	23,99 62,13 13,88	24,65 57,13 18,22	24,45 58,62 17,07
	Texture Class	Silty Loam	Silty Loam	Silty Loam

Source: Results of Analysis of Laboratory of Soil Science and Forest Nutrition, University of Mulawarman, Samarinda(2022)

Information : VA =very acidic, VL = very low, L = low, M = moderate, H = high,

VH = very high

Based on data from soil analysis in the laboratory, the chemical and textural characteristics of the soil under ironwood and meranti stands are as follows:

1. Soil pH

The soil pH in the ulin stands was between 4.18 – 4.39 and the soil pH in the meranti stands was between 4.35 – 4.51. The soil pH under the two stands was very acidic. In line with the results of research reported by Triadiawarman (2013) that the soil pH under ironwood stands in the forest area of Kutai National Park (TNK) ranges from 4.6 to 5.8 (classified as very acidic to slightly sour), and reported by Sari et al. (2019) that the acidity of the soil under the Shorela leprosula Miq stand ranges from 4.10 – 5.12 (very acidic to sour). The low soil pH can be caused by base cations that have been leached due to rainwater. It was stated by Munawar (2011) that high rainfall was an effective cause of the loss of base cations from the soil solution which were replaced by acidic Al and H cations.

2. C-Organic Content

Soil C-organic content in ironwood stands between 0.32 – 0.75% is classified as very low, and C-organic content in meranti stands between 0.77 – 1.27% is classified as very low to low. The results of another study reported by Triadiawarman (2013) stated that the C-organic content under ironwood stands in the Kutai National Park (TNK) forest area ranged from 0.04 – 0.27 (classified as very low), and was reported by Mulyadi and Arruan (2020) that the C-organic content in the Samboja Wanariset under Dipterocarp stands is 1.22 – 2.16% (classified as low to moderate) and under non Dipterocarpa stands ranges from 0.52 – 5.95 (classified as very low to high) . The C-organic (organic matter) content of soil is influenced by several factors such as climatic conditions, texture and type of vegetation. Munawar (2011) stated that the total organic matter content in tropical soils is only about 5%. The low organic matter content is due to rainfall and high temperatures and sandy soil texture accelerates the decomposition process of organic matter, so that the organic matter content in the soil becomes low.

3. N-Total Content

The total N-content of the soil in ironwood stands between 0.17 – 0.20% was classified as moderate, and the total N-content in meranti stands between 0.27 – 0.30% was also classified as moderate. The results of the study reported by Triadiawarman (2013) stated that the total N-content under ironwood stands in the Kutai National Park (TNK) forest area ranged from 0.37 – 2.68% (classified as very low to very high) later reported by Mulyadi and Arruan (2020) stated that soil total N-levels in Dipterocarpaceae nuftar plasma gardens were low, ranging from 0.12% to 0.19%. N-total levels in non-Dipterocarpaceae tree species varied from very low to moderate, namely between 0.03 – 0.36%. The presence of total N in the soil in both meranti stands and ironwood stands is related to soil organic matter content. Hardjowigeno (2015) stated that the ability of the soil to provide N is largely determined by the condition of the amount of soil organic matter. Furthermore, Bakri et al (2016) stated that the higher the organic matter in the soil, the higher the N content in the soil.

4. P-Available Content

The available P content of soil in ironwood stands was between 28.53 – 52.72 ppm classified as moderate to high, and the available P content in meranti stands between 25.01 – 69.50 ppm was classified as medium to very high. The results of this study are in line with the results of research reported by Triadiawarman (2013) that the available-P content under ironwood stands in the forest area of Kutai National Park (TNK) ranges from 2.85 – 34.96 ppm (classified as very low to high); Then it was reported by Sari et al (2019) that the CEC of the soil under the Shorela leprosula Miq stands ranged from 2.84 – 3.71 ppm (classified as very low). Winarso (2005) explained that the factors that affect the availability of P in the soil are the amount and type of clay, organic matter content, soil P status, other nutrients, soil pH, temperature, aeration and plants.

5. Content of Cation Exchangeable Bases

On ulin stands, the content of Ca^{++}between 0,48 – 0,88 me/100 g soil (classified as very low), content of Mg^{++}between0,68 – 1,33 me/100 g soil (classed low to medium), content of K^{+}between 0,22 – 0,35 me/100 g soil (classed low), and content of Na^{+}between 0,08 – 0,11 me/100 g soil (classed low). This is in line with the results of a study reported by Triadiawarman (2013) that under ulin stands the content of Ca^{++}between0,41 – 6,40 me/100 g soil (classified from very low to low), content ofK+ between0,06 - 0,22 me/100 g soil (classified as very low to low) and Mgbetween0,11 - 3,40 me/100 g soil (classed from very low to high).

On merantistands,the content of Ca^{++}between0,88 – 1,27 me/100 g soil (classified as very low), content of Mg^{++}between0,48 – 1,52 me/100 g soil (classed low to medium), content of K^{+}between0,18 – 0,28 me/100 g soil (classed low), and content of Na^{+}between0,17 – 0,19 me/100 g ground (classed low). The results of another study were reported by Sari et al (2019) that under the stands of *Shorela leprosula* Miqnamely content of Ca^{++}between1,66-4,18 me/100g (classified as very low to low); content of Mg^{++}between0,17-0,24 me/100 g(classified as very low); content of K+ between0,10 – 0,20 me/100 g soil (classified from very low to low); and content of Na+ between0,07 – 0,13 me/100 g land (classed from very low to low). In general, the content of basic cations both under ironwood and meranti stands was low. This situation was explained by Sanches (1976) in Nurhayati Hakim et al (1986) that it is common in areas with high rainfall that causes base cations to be washed out of the adsorption complex and lost with the drainage water, so that the content of base cations in the the ground is low.

6. Cation Exchange Capacity

The cation exchange capacity of the soil on ulin stands was between 5.71 – 7.83 me/100 g of soil (classified as low), and the cation exchange capacity of the soil on meranti stands was between 8.39 – 9.08 me/100 g of soil (classified as low) . The results of this study are in line with the results of research reported by Triadiawarman (2013) that the CEC under ironwood stands in the Kutai National Park (TNK) forest ranged from 0.99 – 5.17 me/100 g of soil (classified as very low to low). Then it was reported by Sari et al Sari et al (2019) that the CEC of the soil under the *Shorela leprosula* Miq stands ranged from 5.40 – 9.80 (classified as very low). Furthermore, it was stated by Nurhayati Hakim et al (1986) that the size of the soil CEC value was influenced by the nature and characteristics of the soil itself, namely pH, texture, type of clay minerals, organic matter content, liming and fertilization.

7. Base Saturation

The soil base saturation in ulin stands was between 27.10 – 34.46% which was low, and the soil base saturation in meranti stands was between 18.98 – 35.08 me/100 g of soil which was very low to low. The results of this study are in line with the results of research reported by Triadiawarman (2013) that base saturation under ulin stands in the Forest Area of Kutai National Park (TNK) ranges from 9.05 – 42.57% (classified as very low to moderate); Then it was reported by Sari et al (2019) that base saturation under the *Shorela leprosula* Miq stands ranged from 10-16% (classified as very low). In connection with base saturation, Nurhayati Hakim et al (1986) explained that the value of base saturation is largely determined by climatic conditions (rainfall) and the pH of the soil.

8. Soil Texture

In ironwood stands, the percentage content of sand, silt and seat fractions, respectively 34.86%, 57.38% and 7.76%, were classified as silt loam textured welds; In the stands, the percentage content of sand, silt and lait fractions, respectively 23.99%, 62.13% and 13.88%, belonged to the silty loam texture class. This situation indicates that the composition of soil particles both under ulin and meranti stands is dominated by sand and silt fractions. Sarief (1989) explained that sand and dust particles have a larger size compared to clay particles, therefore the surface area of sand and dust is small, so their role in participating in regulating the chemical properties of the soil is also very small. The greater the percentage of the sand fraction in the soil, the more macro pore space between soil particles, thus facilitating the movement of water and air.

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

Based on the results of the research and discussion, conclusions are drawn, namely as follows:

1. The chemical characteristics of the soil under ironwood stands, namely: soil pH (very acidic), organic-C content (very low), total N-content (very low), available-P content (medium to high), cation content of Ca^{++}, K^{+} and Na^{+} basic cations (very low to low), cations of Mg++ (low to medium), CEC and saturation (low), silty loam soil texture class.
2. The chemical characteristics of the soil under the meranti stands are: soil pH (very acidic), organic-C content (very low to low), total N-content (medium), available-P content (medium to very high), cation content of Ca^{++}, K^{+} and Na^{+} base cations (very low to low), cations Mg++ (low to moderate), CEC (low), base saturation (very low to low), silty loam soil texture class.

B. Suggestion

1. To improve the quality of soil fertility in both ironwood and meranti stands, it is necessary to apply organic and inorganic fertilization as well as lime application.
2. It is necessary to carry out further research to determine the growth response of ironwood and meranti plants to various treatments of liming and fertilizing.

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