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Abstract. Peat soil is a soil with low nutrient content, due to the weathering process of organic materials in peat land not taking place well. The characteristics can be observed in its physical, chemical, and biological properties. This study aimed to determine the chemical characteristics of peat soil in the Humbang Hasundutan Regency. The chemical characteristics of peat soils include the degree of acidity (pH), nitrogen (N), and phosphorus (P). Peat soil samples were obtained from Lintong Ni Huta District, Dolok Sanggul District, and Pollung District. The results of the pH parameter testing in the Lintong Ni Huta District, Dolok Sanggul 1 District, Dolok Sanggul 2 District, and Pollung District were 4.56, 4.42, 4.61, and 4.68, respectively. Testing of N parameter on peat soil showed that the peat soil originating from Lintong Ni Huta District was 0.7387%, Dolok Sanggul 1 District was 0.6738%, Dolok Sanggul 2 District was 0.4657%, and Pollung District was 0.8352%. Testing of the P parameters on peat soil showed that the peat soil originating from Lintong Ni Huta District, Dolok Sanggul 1 District, Dolok Sanggul 2 District, and Pollung District were 0.2951 %, 0.3995 %, 1.4903 %, and 1.252 %, respectively.

Keywords: peat, characteristics, chemical

1 Introduction

Soil is a free accumulation of natural plants and occupies most of the top layer of Earth’s surface. There are four layers of soil: top soil layer (topsoil), bottom soil layer (subsoil), weathered parent rock layer (regalith), and parent rock layer (bedrock) [1].

Based on data on the area of peatland in Indonesia in the Decree of the Minister of Environment and Forestry of the Republic of Indonesia (Number SK.129/MENLHK/SETJEN/PKL.0/2/2017 concerning Determination of the National Peat Hydrological Unit Map, Indonesia has 865 Peat Hydrological Units (KHG) with a total area of ± 24,667,804 Ha, evenly distributed on Sumatra Island with 207 KHG covering an area of ± 9,604,529 Ha, Kalimantan Island with 190 KHG covering an area of ± 8,404,818 Ha, Sulawesi Island with 3 KHG covering an area of ± 63,290 Ha, and Papua Island, a total of 465 KHG covering an area of ± 6,595,167 Ha.

Peat soil is usually found in backswamp or basin areas with poor drainage. Peat soil is defined as soil that has a layer rich in organic matter with a thickness of 50 cm or more, formed from deposits of plant tissue that have not completely decayed owing to water-saturated and nutrient-poor environmental conditions [2].

Peat soil is formed from accumulated organic material; therefore, the carbon content of peat soil is very high. This accumulation occurred because the rate of decomposition was slow compared to the rate of accumulation of organic material on the surface of the wetland. Peat formation almost always occurs on land under flooded conditions with the production of large amounts of organic material.

Peat land is marginal land for the agricultural and plantation sectors because of its low soil fertility, which is caused by the soil being very acidic (pH < 7), the content of macro elements (K, Ca, Mg, N, and P), and the content of micro elements (Cu, Zn, Mn, and B) is also low [3]. So it is necessary to process peatland properly so that it can be used as planting land.

According to [4] states that one of the areas in North Sumatra that has a lot of peat soil is Humbang Hasundutan Regency. It is estimated that there are around 1,042 ha of peatland in Humbang Hasundutan, spread across Lintong Nihuta District, Pollung District, and Doloksanggul District. Since peat is usually found in lowlands near the coast, it in this area is considered unique and rare. However, peat in the Humbang Hasundutan area is highland peat (topogenous) located between 1000 and 1450 meters above sea level.

2 Methodology
This research was carried out in Humbang Hasundutan Regency. The location of the peat land is in the Lintong Ni Huta District, Dolok Sanggul District, and Pollung District. Peat soil samples were taken from the topsoil, 10 cm from the ground surface, this is due to the fact that the root region of the plant is located at a depth of 10 cm in the ground [5]. Soil samples come from the characteristics of land types based on the plants cultivated or grown, namely,

**Table 1. Characteristics of Origin of Peat Soil Samples**

<table>
<thead>
<tr>
<th>No.</th>
<th>Subdistrict</th>
<th>Land Type</th>
<th>Type of Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lintong Ni Huta (L)</td>
<td>Open Field</td>
<td>Ferns and Weeds</td>
</tr>
<tr>
<td>2</td>
<td>Dolok Sanggul (DS1)</td>
<td>Cultivation</td>
<td>Corn</td>
</tr>
<tr>
<td>3</td>
<td>Dolok Sanggul (DS2)</td>
<td>Cultivation</td>
<td>Coffee</td>
</tr>
<tr>
<td>4</td>
<td>Pollung</td>
<td>Natural forest</td>
<td>Trees and shrubs</td>
</tr>
</tbody>
</table>

The test parameters for the chemical characteristics of peat soil included the degree of acidity (pH), nitrogen (N), and phosphorus (P). The properties, characteristics, and fertility of the soil are largely influenced by the chemical characteristics of the soil. Clay and organic matter, examples of colloidal materials, are active soil ingredients that help absorb and exchange ions. Both of these colloidal materials help regulate and provide nutrients to plants directly or indirectly. The availability of soil nutrients (N and P) is one of the factors that affect plant growth [6]. pH, nitrogen, and phosphorus are fundamental chemical factors that directly influence plant growth and productivity. Monitoring these parameters provides valuable insights into the soil’s capacity to support vegetation and agricultural crops. Peat soils have distinct properties compared to other soil types, characterized by high acidity, low nutrient availability, and unique organic matter composition. Assessing pH, nitrogen, and phosphorus levels allows for a targeted evaluation of these critical aspects of peat soil chemistry. By prioritizing key chemical parameters such as pH, nitrogen, and phosphorus, the author may have aimed to streamline the analysis process while still capturing essential information relevant to soil fertility and management.

Soil pH is very important to determine how easily nutrients are absorbed by plant roots; in neutral soil pH, most nutrients are easily soluble in water and facilitate the absorption process of plant roots [6]. The nutrients Nitrogen (N) and Phosphorus (P) are essential for plant growth and reproduction. The synthesis of chlorophyll depends on nitrogen. Chlorophyll determines the color of the leaves. Phosphorus aids plant growth by facilitating fruit and flower formation, helping plants reach maturity, proper root development, and increasing growth rate [7]. Analysis of the phosphorus content in the soil helps the farmer to determine whether additional phosphorus fertilizers are needed and in certain doses. By conducting pH, N, and P analyses on peatlands, farmers can optimize fertilization and crop management to achieve better yields, minimize environmental damage, and maintain the sustainability of their livelihoods.

The above soil chemical characteristics, analyzed in the Laboratory of PT. SOCFINDO North Sumatra Province, using the following test methods:

**Table 2. Parameter Testing Method**

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pH</td>
<td>SOC-LA/IK/12 (Potentiometry)</td>
</tr>
<tr>
<td>2</td>
<td>Nitrogen</td>
<td>SOC-LA/IK/07 (Kjehldald)</td>
</tr>
<tr>
<td>3</td>
<td>Phosphor</td>
<td>HNO# with Spectrophotometer</td>
</tr>
</tbody>
</table>

**3 Result and Discussion**

**3.1 pH**

In this study, the degree of soil acidity in the Humbang Hasundutan Regency was measured using a pH parameter. The test results showed that all soil samples had acidic pH, with a pH value of less than 7 (pH < 7). These results are in line with the findings of previous research conducted by Hidayat et al. (2022) on peatlands in Riau Province, which showed that peat soils tend to have a low pH ranging from 3 to 5.

![Fig. 1. The pH of peat soil in Humbang Hasundutan Regency](image-url)

In this research, the soil from Dolok Sanggul 1 District showed the lowest pH, namely 4.42, followed by Lintong Ni Huta District with pH 4.56, Dolok Sanggul 2 District with pH 4.61, and Pollung District with pH 4.68. Based on these results, it can be stated that the soils in this region generally have relatively low acidity levels compared to the ideal pH contained in peat soils. According to Lucas and Davis in [8], pH with a value of 5.5 is the ideal pH level for nutrient availability in peatlands. The results of the acidic pH content in this
soils with high pH that contain a lot of OH− ions [12]. This mechanism works better in coarse-textured soils where water can seep freely. However, on fine-textured and more permeable soils, percolation is slower. NH₄⁺ nitrogen loss is less common and occurs mostly during evaporation. BASICALLY, ammonium ions are molecules of anhydrous ammonia (NH₃) with the addition of hydrogen ions (H⁺). When additional H⁺ is removed from the NH₄ ion by another ion, such as hydroxyl (OH−), the resulting NH₃ molecule can evaporate, or evaporate from the soil. This mechanism works better in soils with high pH that contain a lot of OH− ions [12].

The acidic pH of the soil has implications for the ion exchange capacity (CEC) and nutrient balance. Acidic soils can result in high CEC and low base saturation, which in turn can result in nutrient deficiencies. Therefore, this research suggests the need to add micro- and macronutrients to the right amounts and doses to increase soil fertility [9].

Acidic soils require special processing to increase soil fertility and the availability of plant nutrients. The addition of nutrients can be achieved by using CaMg(CO₃)₂ dolomite, as explained by [11]. The addition of dolomite to peat soil in this study increased the pH value. tons/ha, namely 2.5 tons/ha; 5 tons/ha; 7.5 tons/ha; and 10 tons/ha, respectively, showing a proportional increase in the pH value of peat soil. Thus, the greater the dose of dolomite, the greater the increase in pH.

The increase in peat soil pH due to the addition of dolomite is thought to occur because hydrolyzed dolomite contributes OH− ions that can neutralize H⁺ ions in the soil solution, thereby increasing soil pH. The higher the dose of dolomite, the more OH− ions are involved in this process, and as a result, the soil pH increases. Therefore, increasing the dolomite dose is an effective solution to overcome the problem of soil acidity in this region.

3.2 Nitrogen (N)

Testing of Nitrogen (N) parameters in soil in Humbang Hasundutan Regency produced data showing variations in N content in several sub-districts, namely, Lintong Ni Huta District, Dolok Sanggul 1 and 2 Districts, and Pollung District. The highest N content was found in soil from Pollung District, reaching 0.8352%, followed by Lintong Ni Huta District with 0.7387%, Dolok Sanggul 1 District with 0.6738%, and Dolok Sanggul 2 District with 0.4657%. Low nitrogen levels in the soil, as explained by [6], can be caused by evaporation and leaching factors that accelerate nitrogen loss.

When excess water seeps through the soil, nitrate forms nitrogen easily soluble. This is a significant loss mechanism on coarse-textured soils where water can seep freely. However, on fine-textured and more impermeable soils, percolation is slower. NH₄⁺ nitrogen loss is less common and occurs mostly during evaporation. BASICALLY, ammonium ions are molecules of anhydrous ammonia (NH₃) with the addition of hydrogen ions (H⁺). When additional H⁺ is removed from the NH₄ ion by another ion, such as hydroxyl (OH−), the resulting NH₃ molecule can evaporate, or evaporate from the soil. This mechanism works better in soils with high pH that contain a lot of OH− ions [12].

Low nitrogen levels in the soil have important implications, especially for plant growth. According to [13], plants take up nitrogen through ammonium (NH₄⁺) or nitrate (NO₃⁻) ions found in the soil. Therefore, even though nitrogen levels are low, plants still require it for optimal growth.

Peatlands in the Humbang Hasundutan Regency have potential as agricultural cultivation lands. However, the availability of nitrogen nutrients in peat soils tends to be low. As a solution, research by [14] in peat soil in South Kalimantan shows that applying fertilizer made from vegetable waste at certain doses can increase plant height, number of leaves and fresh weight of kale leaves. This shows that the use of organic waste can be a solution for increasing the availability of nitrogen in peat soils.

Used palm oil blanks (tankos) as raw materials for compost showed positive results. Compost with a composition of 50% peat and 50% tankos compost had an average nitrogen value of 1.46%, which is classified as very high [15]. Research by [16] also showed that tankos ash contains N-total with a medium category of 0.21%. Thus the application of tankos ash at increased doses also increases the total N amount of soil. This shows that the use of compost can be an effective alternative for increasing the availability of nitrogen in peat soils [15].

In the context of the Humbang Hasundutan Regency, increasing the availability of nitrogen in the soil can be a priority, especially in Dolok Sanggul 1 District, which functions as corn cultivation land, and Dolok Sanggul 2 District, which functions as coffee cultivation land. In addition, the same treatment can also be applied to land that currently has vegetation of trees, bushes, ferns, and weeds in the Lintong Ni Huta and Pollung Districts, which can be used as cultivation land. Thus, increasing nitrogen nutrients through the use of organic materials or compost can be an effective strategy for rehabilitating peatlands and increasing agricultural productivity in the region.
3.3 Phosphorus (P)

Based on the results of testing the Phosphorus (P) parameter on soil samples from Humbang Hasundutan Regency, it can be seen that the highest proportion of P is found in soil samples from Dolok Sanggul 2 District, amounting to 1.4903%. Other samples had different proportions of P, with Pollung District having 1.252% in Dolok Sanggul 1 District, 0.3995% in Dolok Sanggul District, and 0.2951% in Lintong Ni Huta District. Increasing the P content in the soil is important because this element plays an important role in root growth and shoot formation in plants.

In peat soils in Humbang Hasundutan Regency, the content of high amounts of organic acids, including humic acid and fulvic acid, greatly affects plant growth related to nutrients needed by plants. The low pH of peat soil is closely related to the content of organic acids that have undergone decomposition having carboxyl and phenol reactive groups which are weak acids [21]. Improvement efforts are needed through a topogenic approach to maintain the stability of peat soil chemical parameters in accordance with applicable regulations. Evaluations of the suitability of peatlands for specific crops, such as those carried out by [20] in Muaro Jambi District, can provide additional insights into soil conditions and expanded recovery strategies. It is important to understand that the decomposition process of organic material in peat soil can be hampered by conditions that tend to contain high water content, as can occur in the Humbang Hasundutan Regency. Therefore, efforts to increase the P content in peat soil by increasing the decomposition of organic matter need special attention in land rehabilitation efforts and increasing peat soil fertility in the region.

4 Conclusion

Research on the chemical properties of the Humbang Hasundutan Regency has yielded various interesting findings. First, the four study sites had acidic soil pH (4.42–4.68). Second, the Pollung District peat soil had the highest nitrogen content (0.8352%). Plant development requires sufficient nitrogen. However, low results in some research sites suggest remedial actions, such as providing nutrients or using organic materials. Dolok Sanggul 2 (DS2) soil had the highest phosphorus (1.4903%). The synthesis of energy molecules and plant development is dependent on phosphorus. Even if certain areas have high phosphorus levels, the entire distribution must be considered when planning recovery activities. This research covers the Humbang Hasundutan Regency peat soil conditions in detail. Soil complexity is shown by acidity and nitrogen and phosphorus levels. Focused modification and management techniques aimed at promoting soil nutritional balance, supporting sustainable agriculture,
and preserving the ecology of a region, such as incorporating organic matter through practices like composting, mulching, and green manure adds nutrients to the soil, enhances soil structure, and increases water retention. One way to deal with damage to peatland ecosystems is by blocking canals. Canal barriers are installed to increase water retention in the canal body and its surroundings and prevent water level subsidence in peatlands. This makes the surrounding peatland wet and difficult to burn. Canal barriers function by holding and holding water in the Peatland Hydrological Unit (KHG) area for as long as possible [22].

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