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Diversity of fungal species and decomposition of *Rhizophora mucronata* leaf litter in the Deli Belawan River Estuary, North Sumatra, Indonesia

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Abstract. *Yunasfi, Lubis SR, Utomo B, Dalimunthe A, Sihotang VM, Sembiring S, Sitepu GA, Purba JGM, Silalahi R, Susetya IE, Fadhilah A, Noer Z. 2025. Diversity of fungal species and decomposition of* Rhizophora mucronata *leaf litter in the Deli Belawan River Estuary, North Sumatra, Indonesia. Biodiversitas 26: 1631-1640. Rhizophora mucronata* is one of the most widely known mangrove species, growing in coastal areas, such as along river estuaries, deltas, and lagoons. This species produces leaf litter that is useful for organisms living in mangrove water after decomposition. The decomposition of *R. mucronata* leaf litter is often affected by the presence of salinity in seawater including other environmental factors such as pH, humidity, rainfall, temperature, and river current speed. Fungi played an important role in the process of litter decomposition by facilitating the degradation of organic compounds such as cellulose and lignin which are components of leaf cell walls. The aim of this study was to determine the fungal species diversity and decomposition of *R. mucronata* leaf litter at salinity levels of 0-10 ppt in the Belawan Deli River. The study used 24 bags of 40 × 30 cm litter bags. Fungal isolation was carried out using the dilution method to calculate the number of fungal colonies in *R. mucronata* leaf litter. Furthermore, the analysis of carbohydrate and protein contents in *R. mucronata* leaf litter was carried out using the semi-micro method (01-2891-1992 SNI). The results of isolation showed that species of fungi were associated with *R. mucronata* leaf litter, namely *Aspergillus* sp.1, *Aspergillus* sp. 2, *Aspergillus* sp. 3, *Penicillium* sp., *Trichoderma* sp. The decomposition rate of *R. mucronata* leaf litter was 0.018/year. The average percentage of total carbohydrates and proteins was 9.33 and 5.54%, respectively. Based on the outcomes found in this research, the author suggested to conduct research on *R. mucronata* leaf litter at salinity levels of 11-20 ppt and 21-30 ppt to further observe the diversity of fungal species.

Keywords: *Aspergillus* sp., decomposition, fungi, mangrove, salinity

INTRODUCTION

Mangrove ecosystem is a type of forest that grows in tidal areas inundated with water at high tide. According to Saranraj and Sujitha (2015), mangroves are a collection of halophytic woody plants found in tropical and subtropical estuarine or brackish habitats. Approximately 75% of the world's tropical coastlines are covered by mangrove forests, contributing important nutrients to the soil through fallen litter which is incorporated into the sediment (Srisunont et al. 2017; Carugati et al. 2018). Mangrove forests function as an important component in a very complex food chain and have the potential for the life of various marine and terrestrial biota, both microorganisms and macroorganisms (Abrantes et al. 2014). The weathering material in these forests comes from mangrove tree organs, namely leaf, flowers, branches, twigs, and several other tree parts that fall to the forest floor, called litter. The fertility factor of the ecosystem is leaf litter that falls and undergoes a decay process. Litter is decomposed by microorganisms produces organic matter absorbed by plants with some dissolving, carrying low tide into the surrounding waters. Microorganisms that play a role in decomposition are fungi (Yunasfi et al. 2021). Generally, fungi are important soil components serving as decomposers and plant symbionts, playing a major role in ecology and biogeochemical processes (Hossain et al. 2014; Liu et al. 2015; Tennakon et al. 2021). *Rhizophora mucronata* is a mangrove plant species with a habitat near or located on tidal riverbanks and in river estuaries. This species is one of the core mangrove flora, which has a significant role in mangrove ecosystem (Kusmana et al. 2014).

Litter production is important in transferring organic matter from plants to soil. This is because nutrients produced from litter decomposition in the soil serve as a source of detritus for marine and estuarine ecosystem to support several aquatic biotas. Microorganisms decompose fallen mangrove litter, which enters the food chain to provide nutrients for organisms living in the water (Hafizi et al. 2017; Alam et al. 2021). The process is facilitated by

the addition of microorganisms such as fungi to leaf litter. Furthermore, decomposition is strongly influenced by decomposers' presence in number and diversity. As part of productivity area, leaf litter produces simple essential nutrients which are used to support mangrove growth (Dharmawan et al. 2016). The rate of decomposition is often affected by environmental factors, such as pH, climate, chemical composition, and microorganisms (Devianti and Tjahjaningrum 2017). Kristensen et al. (2017) stated that litter decomposition process in floor mangrove forests was influenced by several parameters, including mangrove species, season, and stand position in the intertidal zone. Many studies on decomposition have been carried out, both in tropical and subtropical regions (Li and Ye 2014; Tran 2014; Keuskamp et al. 2015).

The decomposition of *R. mucronata* leaf litter is affected by fungi and salinity level, which determine the abundance of microorganisms (Lailatussyifa et al. 2020). Generally, salinity level of 0-10 ppt affects the number of fungi in the mangrove ecosystem. Mangrove leaf litter is a food source for biota, which are decomposed by worms, crabs, and other trapping tools. Furthermore, an important aspect of this ecosystem is exporting organic material, which is essential for coastal areas (Taketani et al. 2018). The release of nutrients from mangrove leaf litter also plays a significant role in biogeochemical cycles in the aquatic environment. This process directly or indirectly affects water quality as well as food availability for fish and shrimp (Alam et al. 2021). Mangrove also serves as an environment where fungi can develop because of the large amount of litter produced by the vegetation (Raghukumar 2017). Fungi play an important role in decomposition of mangrove lignocellulosic materials. Tennakoon et al. (2021) stated that there are three main factors influencing decomposition process of litter, particularly leaf, namely the physical and chemical conditions of the environment, quality, and composition of decomposer community. Among various decomposers, fungi are considered one of the most active microorganisms, specifically in the early stages of decomposition (Raghukumar 2017). Moreover, changes over time in a coordinated manner through the process known as succession (Moitinho et al. 2018). During this process, mud worms eat leaf litter and turn it into smaller fragments (Krishna and Mohan 2017). The time required to lose 50% of the initial dry mass (t1/2) is 49.55 days for *A. marina* and 44.43 days for *R. mucronata*. The aim of this study was to determine the fungal species diversity and decomposition of *R. mucronata* leaf litter at salinity levels of 0-10 ppt in the Belawan Deli River.

MATERIALS AND METHODS

Time and location

The study was conducted from August 2023 to February 2024 at the Forest Cultivation Laboratory, Faculty of Forestry, Universitas Sumatera Utara and Medan Industrial Research and Standardization Center. *Rhizophora mucronata* leaf litter was collected from the mangrove ecosystem in Belawan, Medan City, North Sumatra, Indonesia (Figure 1).

Tools and materials

The tools used were litter bags measuring 40 × 30 cm, stakes, scales, plastic entangles, raffia, camera, stationery, oven, refractometer, laminar air flow, analytical balance, Beaker glass, Erlenmeyer flask, magnetic stirrer, test tube, stove, mortal, micropipette, microscope, object glass, cover glass, and Petri dish. The materials used were *R. mucronata* leaf litter and seawater, distilled water, cotton, aluminum foil, cling wrap, alcohol, sugar, and spiritus.

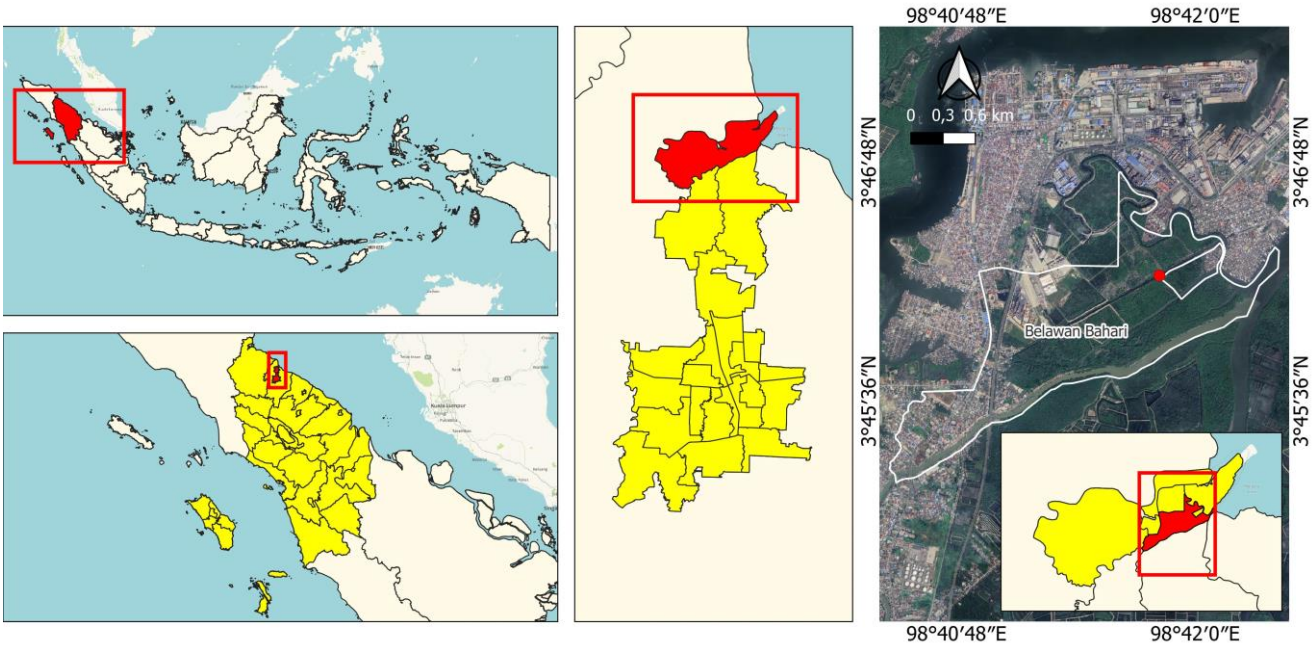

Figure 1. Location of the study area in the mangrove ecosystem of Belawan, Medan City, North Sumatra, Indonesia

Procedures

Location determination based on salinity level

The study was conducted in the Deli River area, Belawan, and the Forest Cultivation Laboratory, Faculty of Forestry, Universitas Sumatera Utara (3°45'44.4"N 98°41'27.1"E). Using a hand refractometer, data collection method applied purposive sampling through consideration was used to determine the station point based on differences in salinity.

Collection and placement of Rhizophora mucronata *leaf litter in the field*

Approximately 1200 g of *R. mucronata* leaf litter was collected from the field. Each 50 g of leaf litter was put into a bag measuring 40 × 30 cm and made of 1 × 1 mm nylon mesh, comprising 24 pieces, with 8 observations × 3 replications. Bags were placed in the field at salinity level of 0-10 ppt when the tide was flooded. To avoid being washed away by the tide, bags were placed by tying the four ends using 1 × 1 m bamboo pole. Litter tied using a stake was planted on the ground. Subsequently, the bags were collected every 15 days with approximately three bags, totaling six collections by 90.

Data collection of Rhizophora mucronata *leaf litter*

Rhizophora mucronata leaf litter was placed at salinity level of 0-10 ppt, followed by monitoring decomposition over time: a. day 0; b. day 15; c. day 30; d. day 45; e. day 60; f. day 75; g. day 90. Each observation was carried out on three bags of litter until 90 days weighing 50 g. After taking the bag from the field, litter was cleaned of dirt, such as mud. Subsequently, a 10 g sample was taken from each bag for isolation and the remaining was air-dried to get the wet weight. The remaining litter was put into an envelope and dried in laboratory using an oven at 75°C for 3 days to achieve a constant weight.

Isolation of fungi from Rhizophora mucronata *leaf litter*

10 g of *R. mucronata* leaf litter was added into sterile seawater, with a volume of 100 mL. A test tube containing sterile seawater with a volume of 9 mL was then added with 1 mL of suspension from the first dilution. In the next test tube containing 9 mL of sterile water, 1 mL of suspension from the first test tube was added, the suspension had reached 10^{-2}. 0.1 mL suspension was transferred into a petri dish containing PDA media for fungal isolation (Kiraly et al. 1974).

Identification of fungal species

Pure cultures of fungi were rejuvenated on PDA media and incubated for 5-7 days at room temperature. Fungal isolation grown on the media was identified macroscopically by observing the nature of hyphae growth, colony color, and colony diameter. Isolation on the glass slide were left for 3-4 days in room conditions to achieve sufficient growth. The grown fungi were observed using a microscope for hyphae characteristics, hyphae branching species, and conidia properties. The characteristics obtained were matched with the identification key book (Singh et al. 1991; Ellis 1993; Lowen 1995).

Determination of fungal species diversity index

To analyze the data and diversity of fungi, the Shannon-Wiener Diversity Index formula (1949) was used, namely:

$$H' = -\sum_{i=1}^{s} (Pi \ln Pi)$$

$$Pi = \frac{ni}{N}$$

Where:

H' : species diversity
S : number of species
Pi : proportion of total test sample
ni : mumber of the i-th species
N : total number of all species

Estimation of litter decomposition rate

The rate of litter decomposition was obtained using formula (Olson 1963):

$X_t = X_0 . e^{-k t}$
$\ln (X_t/X_0) = -kt$

The following formula was used for determining the length of time litter present (*residence time*) on the forest floor:

1/k

Where:

Xt : dry weight of litter after observation time t (g)
X0 : initial litter weight (g)
e : natural logarithm number (2.72)
k : litter decomposition rate
t : observation time (day)

Procedures of analysis carbohydrate and protein

Analysis of carbohydrate and protein contents in *R. mucronata* leaf litter was carried out using a method developed by the National Standardization Agency (NSA) of Indonesia SNI 01-2891-1992 (1992).

Carbohydrate content

Seven (7) g of ash leaf litter were placed in a 500 mL erlenmeyer flask. Next, 200 mL of 3% HCl solution was added and boiled for 3 hours and cooled with a vertical cooler. The cooled solution was neutralized with 30% NaOH and CH_3COOH to obtain a slightly acidic solution. The solution was then filtered and 10 mL of the filtered was transferred to a 500 mL Erlenmeyer flask, 25 mL of Luff-Schoorl reagent solution and 15 mL of distilled water were added. The mixture was heated for 10 minutes. After the solution has cooled, 20% KI solution and 25 mL of 25% H_2SO_4 are added slowly. Then titration was carried out using 0.1 Na. thiosulfate solution (following the instructions for 0.5% starch solution). Then a blank titration was carried out. The calculation was: (Blank-titrant) × Na thiosulfate × 10. The Luff-Schoorl was used to measure the amount of sugar (mg) in 1 mL. The carbohydrate content was calculated using the following formula:

$$\text{Glucose content} = \frac{w1 \times fp}{w} x\ 100\%$$

Where:
Carbohydrate content: 0.90 × glucose content
w1 : sample weight (mg)
w : glucose contained in 1 mL of thio (mg)
fp : dilution factor

Protein content

2 g of ash leaf litter was put into a 100 mL Kjeldahl flask. Next, 2 g of selenium and 25 mL of concentrated H_2SO_4 were added to the flask. The solution was heated on an electric heater until boiling, until the solution turned bluish green (about 2 hours). After that, solution was cooled and diluted with water. Then 5 mL of the solution was transferred into a distillation tool which was added with 5 mL of 30% NaOH and 5 drops of phenolphthalein indicator were added, then distilled for 10 minutes. 2% boric acid solution were mixed with the indicator. Furthermore, titrated with 0.001 N HCl solution, and a blank determination was carried out. The calculation was done with the following formula:

$$\text{Protein content} = \frac{(V1 - V2) \times N \times 0.014 \times fk \times fp}{w}$$

Where:
w : sample weight (mg)
V1 : volume of 0.01 N HCl used as sample titrant
V2 : volume of HCl used as blank titrant
N : normality of HCl
fp : dilution factor
fk : conversion factor for protein from food in general: 6.25, milk and its processed products: 6.38, peanut butter: 5.46

RESULTS AND DISCUSSION

Fungi associated with *Rhizophora mucronata* leaf litter during decomposition

The isolation results showed that a total of five fungal species were obtained from the leaf litter of *R. mucronata*. Of these, three were from genus *Aspergillus*, one each from *Penicillium* and *Trichoderma*. The average colony count of *Aspergillus* sp. 1 (Figure 2) was 0.34×10^2 cfu/mL observed during the decomposition process of *R. mucronata* leaf litter on days 15, 30, 45, and 90. However, the colony count of *Aspergillus* sp. 1 was not found on days 60 and 75. *Aspergillus* sp. 2 showed results with an average colony count of 0.59×10^2 cfu/mL and a colonization frequency of 75% on 15, 30, 45, 60, 75, and 90 days (Figure 3). Based on the results of Yunasfi et al. (2024) at salinity of 0-10 ppt, approximately the same mangrove types were found in Sembilan Island, namely *Aspergillus* sp. 1 *Aspergillus* sp. 2 comprising 11.30 and 1.99 cfu/mL, respectively.

Aspergillus sp. 3 had an average colony count of 0.47×10^2 cfu/mL with a colonization frequency of 37.5%, obtained on days 15, 60, and 75, while on day 30 and 45 the average colony count of *Aspergillus* sp. 3 was not found (Figure 4). As shown in Figure 5, *Penicillium* sp. had a colonization frequency of 50% and the average colony count was 0.25×10^2 cfu/mL. *Trichoderma* sp. had an average colony of 0.10×10^2 cfu/mL with the least colonization frequency of 25% found in decomposition process on days 30 and 75 while the average colony count was not found on day 15, 45, and 60 (Figure 6; Table 1). Species from the genus *Trichoderma* are also found in mangrove ecosystems, both from sediment isolation and leaf litter from mangrove plants (Rumondang 2024). Similarly, this study discovered that fungi from the genus *Aspergillus* were found in the decomposed leaf litter of *A. marina*, with good biodelignification capabilities (Yunasfi et al. 2024). Valencia and Meitiniarti (2017) stated that *T. harzanium* species had a laccase enzyme functioning as a lignin degradator. The number of species of fungi colonies found in the leaf litter of the Deli Belawan River was very small, compared to other locations.

Table 1. Fungal species found associated with *Rhizophora mucronata* leaf litter

Fungal species	Average number of colonies x 10^2 (cfu/mL)
Aspergillus sp. 1	0.34
Aspergillus sp. 2	0.59
Aspergillus sp. 3	0.47
Penicillium sp.	0.25
Trichoderma sp.	0.10
Total number of colonies	1.75

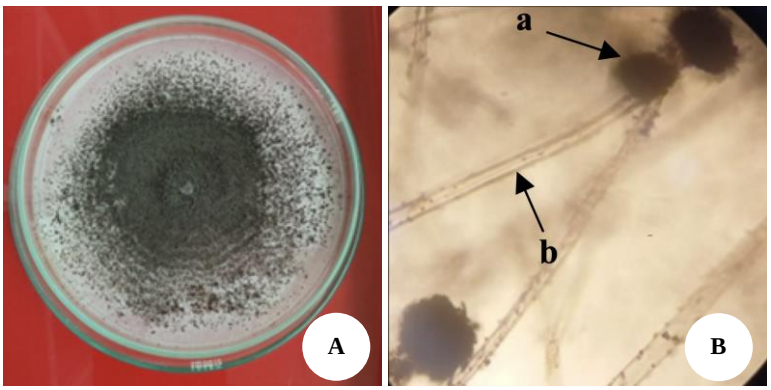

Figure 2. A. Macroscopic *Aspergillus* sp. 1; B. Microscopic form: a. conidia; b. conidiophores; c. hyphae

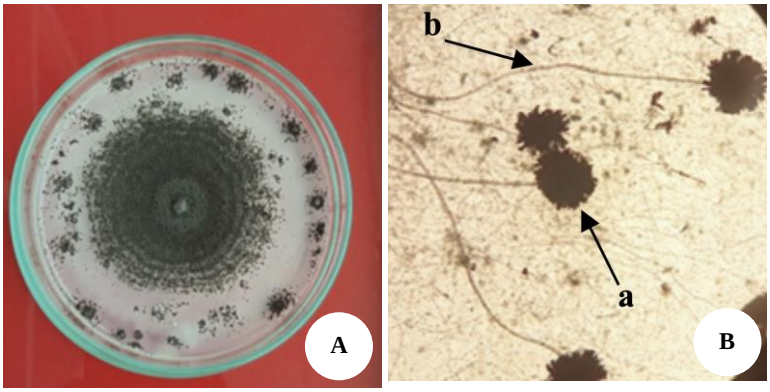

Figure 3. A. Macroscopic *Aspergillus* sp. 2; B. Microscopic form: a. conidia; b. conidiophores

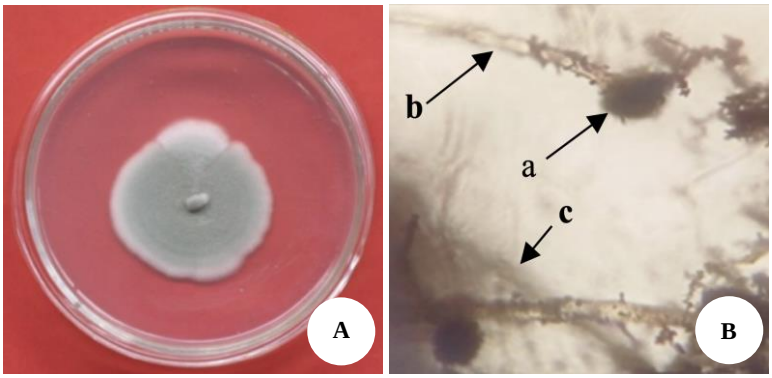

Figure 4. A. Macroscopic *Aspergillus* sp. 3; B. Microscopic form: a. conidia; b. conidiophores; c. hyphae

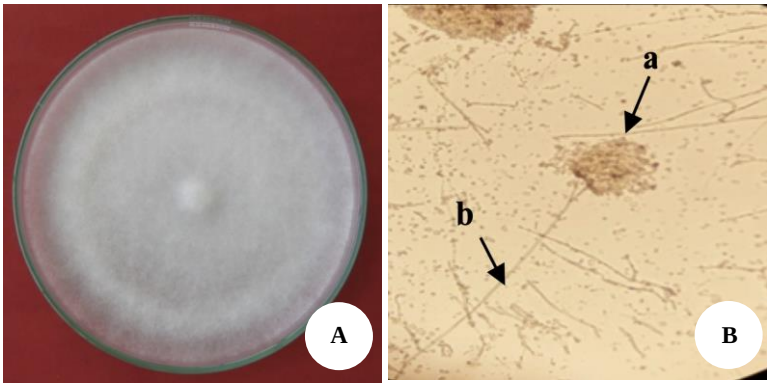

Figure 5. A. Macroscopic *Penicillium* sp.; B. Microscopic form: a. conidia; b. conidiophores

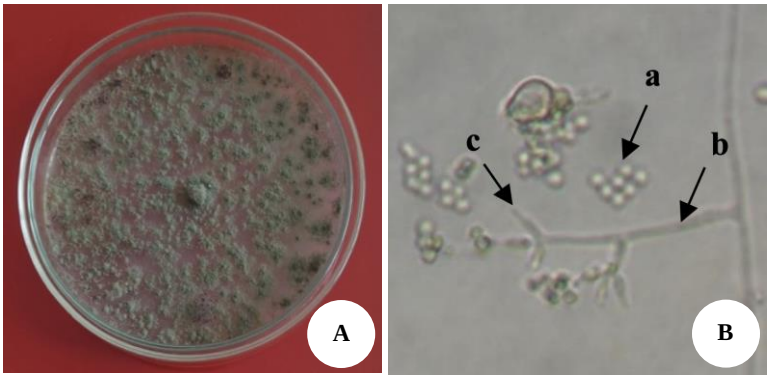

Figure 6. A. Macroscopic *Trichoderma* sp.; B. Microscopic form: a. conidia; b. conidiophores; c. phialides

Table 2. The weight of *Rhizophora mucronata* leaf litter at different time intervals

Observation day	Decomposition rate of *Rhizophora mucronata* leaf litter (g)
Day 0	50
Day 15	27.92
Day 30	25.99
Day 45	19.41
Day 60	17.32
Day 75	6.62
Day 90	5.87

Decomposition rate of *Rhizophora mucronata* leaf litter

The rate of litter decomposition was strongly influenced by the initial organisms in the study location, namely the presence of *Nereis* sp. and Crustacea which shred litter from intact to decomposed form. Fragmentation caused by the activities of soil fauna, such as polychaeta (*Nereis* sp.), can increase the surface area of litter. This process facilitates the release of dissolved substances in litter and increases the colonization area for decomposer microorganisms (Krishna and Mohan 2017). Ouyang et al. (2017) also stated that mangrove areas affected by high tides, these tidal conditions encourage the washing of leaf litter. Therefore, decomposition process in mangrove areas occurs more often than washing of leaf litter due to the ebb and flow of seawater. Mud worms use fallen leaf litter buried in mangrove sediments as a source of fibrous food (Wibowo et al. 2019). The role of this initial decomposer determined the presence of microorganisms that carried out further decomposition, causing a decrease in wet and dry weight. The reduction in wet and dry weight of litter from the first (control) to the sixth observation on day 90 is shown in Figure 7. Based on the results in Table 2, the weight of the remaining litter experienced differences in the decrease with an observation time of 90 days.

The loss of litter dry weight varied from each observation time. During decomposition process, the dry weight was decreased, alongside changes in physical form from whole to small fragments. According to Andriyansah et al. (2023), decomposition is the process of separating organic matter that is still intact into small parts. Decomposition rate was slower in *R. mucronata* leaf litter at the study location. This occurred because study carried out at the river mouth found several plastic and household waste, including pollution coming from fishing boats. Numbere and Camilo (2017) stated decomposition rate was found slower in mangrove locations with high level of pollution.

Figure 8 shows that dry weight of *R. mucronata* litter decreased, identified as daily decomposition. The decomposition was very fast from day 0 to 90, particularly on day 15 at 27.92 g compared to after day 30. This process was followed by a significant reduction until day 90. Previous studies stated that in the first week, decomposition rate is faster and gradually slows down (Loría-Naranjo et al. 2019; Vinh et al. 2020). Sari et al. (2017) also reported that litter produced by mangroves decomposes, starting with the destruction of macrobenthos.

The observation results of the percentage of litter left showed that day 15 had the highest percentage of 55.84%, followed by days 30, 45, 60, 75, and 90 at 54.52, 38.82, 34.64, 13.24, and 11.74%. This condition showed that the lowest percentage was on day 90th, probably because it remained submerged in the tide for the longest time (Figure 9). The remaining weight of litter provides information about decomposition process. In comparison, the percentage of decomposition of litter explains the amount that has been decomposed. Andriyansah et al. (2023) stated that tides contributed to decomposition through weathering simultaneously by salt content along with sunlight, slowly destroying the materials.

Figure 7. The form of *Rhizophora mucronata* leaf litter underwent decomposition for 90 days. A. Control; B. 15 days; C. 30 days; D. 45 days; E. 60 days; F. 75 days; G. 90 days

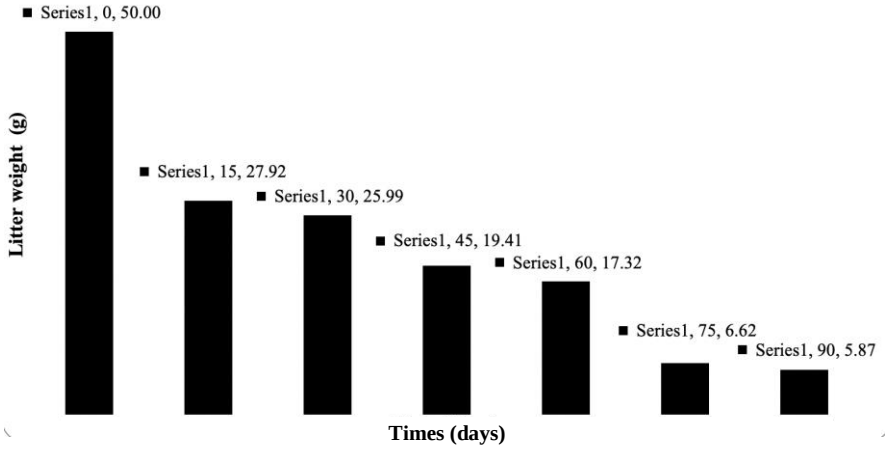

Figure 8. Average residual leaf litter of *Rhizophora mucronata* for 90 days

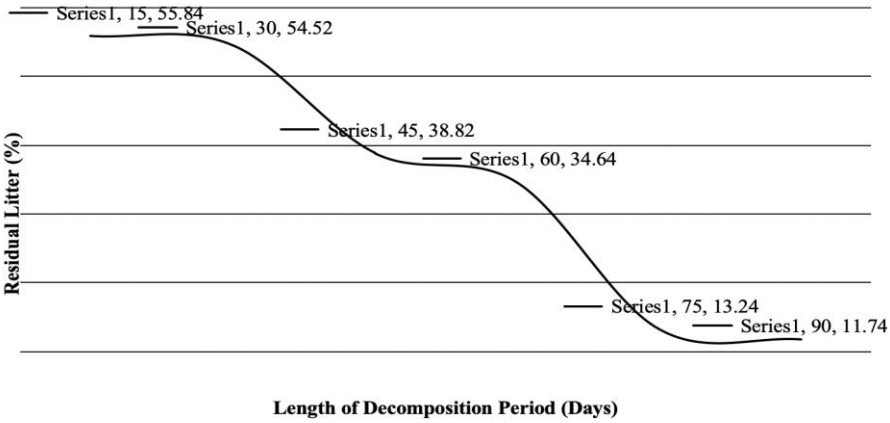

Figure 9. Percentage of decomposition in *Rhizophora mucronata* leaf litter living in litter bags

The reduction in air quantity and the loss of water due to washing also led to the release of dissolved compounds into the environment. This is in line with the results of Graça et al. (2015), where leaf litter that experiences soaking loses 30% of its mass at the beginning of decomposition period. Ouyang et al. (2017) stated that in wetland areas with low oxygen level, such as mangroves, the rate of decomposition is faster when the oxygen content on the surface of the mangrove sediment increases. In mangrove areas, tidal conditions encouraged the washing of leaf litter. This leads to more often decomposition process than due to the flow of seawater. Decomposition rate constant (k) of *R. mucronata* leaf litter calculated using the Olson (1963) formula was 0.018 for day 15 to day 90. During the process, the weight of *R. mucronata* leaf litter decreases. Litter weight loss is inversely proportional to decomposition rate coefficient value (Rumondang 2024).

Macrobenthos

Macrobenthos found at salinity level of 0-10 ppt living in mangrove litter bags play a role as an early decomposer by destroying leaf litter into small parts (Figure 10). This process was continued by small organisms, namely bacteria and fungi (microorganisms) that decompose from organic matter into carbohydrates and proteins.

In the fragmentation process (comminution), mud worms (*Nereis* sp.) play an important role by eating leaf into smaller fragments (Krishna and Mohan 2017). These types of macrobenthos were only found once in the first collection with the Polychaeta, while in the fourth collection, there was a type of Crab. According to Kuriandewa (2003) statement which refers to Watumlawar et al. (2019), microorganisms do not directly decompose litter that falls to the forest floor but require the help of macrobenthos. These macrobenthos act as an initial decomposer breaking down leaf into small parts. The process is followed by microorganisms, namely bacteria and fungi which break down organic materials into proteins and carbohydrates. Specifically, mud worms can survive in ecosystem conditions with high salinity (Wibowo et al. 2020), which helps the process of breaking down litter into smaller fragments.

Salinity

Salinity level of 0-10 ppt has a very low to moderate concentration of water salt content. According to Saibi et al. (2017), decomposition process by bacteria is strongly influenced by environmental conditions, specifically the availability of dissolved oxygen for aerobic bacteria. Salinity level plays a role in decomposition process

because it determines the abundance of microorganisms. This may be because higher salinity level leads to the adaptation and survival of fewer microorganisms. In salinity 0-10 ppt range with a low pH value various types of fungi played an important role in the rate of decomposition of litter.

Carbohydrate and protein content in *R. mucronata* litter

Decomposition process of *R. mucronata* leaf litter occurred from day 15 to day 75. *Rhizophora mucronata* leaf litter experienced a decrease in carbohydrate content. Based on laboratory tests from the Medan Industrial Standardization Research Center, the carbohydrate content on day 0 (control) was 10.4%, which decreased by 10, 9.23, and 7.69% on day 15, 45, and 75, as shown in Figure 11. On day 30 and 60 the changes of carbohydrate and protein content were not significant. This decrease was due to a complex interaction between microorganisms, enzymes, and environmental conditions. Although carbohydrate content decreases over time, the process provides essential nutrients for decomposing organisms and maintains the balance of nutrient cycling in mangrove ecosystems (Latuconsina 2019).

Carbon is the main constituent of organic matter in leaf litter. Organic materials, specifically carbohydrates, are used by decomposers to carry out metabolism, where nutrient C is released in the form of CO_2 (Juottonen 2021). The C:N value in decomposed litter determines the degree of nutrient immobilization, specifically N (Han et al. 2011). Chowdhury et al. (2019) stated that decomposed litter could be considered mature when the C:N value was below 20.

Decomposition process of *R. mucronata* leaf litter occurred from day 15 to day 75. *Rhizophora mucronata* leaf litter experienced an increase in protein content. Based on the laboratory test of the Medan Industrial Standardization Research Center, the protein content before decomposition on day 0 (control) was 5.49%. This was followed by an increase of 5.52, 6.43, and 6.62% on days 15, 45, and 75, as shown in Figure 12. Similarly, Faldin et al. (2016) stated that fat, protein, and carbohydrates were very beneficial for organisms serving as important food for growth, tissue repair, and source of energy.

Based on the analysis of organic and mineral matter in the remaining decomposed *R. mucronata* leaf litter, the percentage of total nitrogen (N) content increased compared to the content in leaf compared to the control. Loría-Naranjo et al. (2019) and Tzec-Gamboa et al. (2023) stated that during decomposition process, N mineralization and immobilization occurred due to the activity of microorganisms.

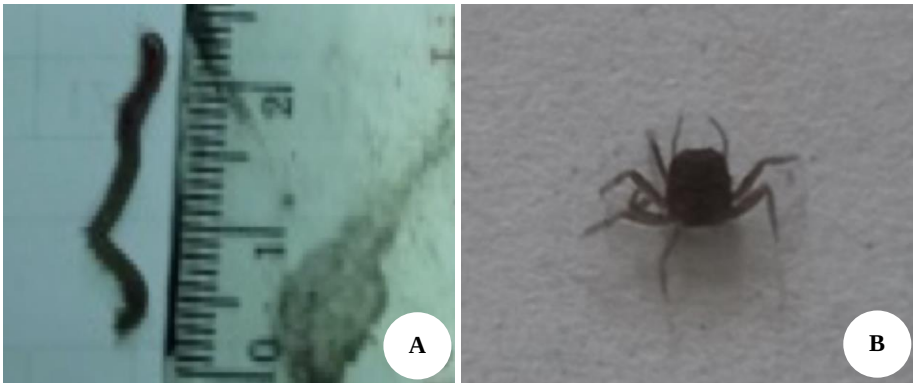

Figure 10. Polychaeta and crab found in litter and *Rhizophora mucronata* decomposing at 0-10 ppt salinity

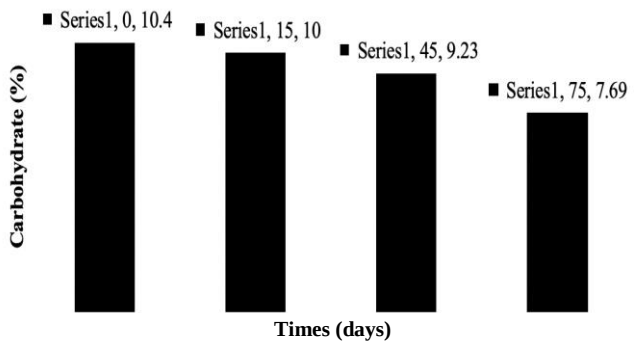

Figure 11. Carbohydrate content of decomposed *Rhizophora mucronata* leaf litter

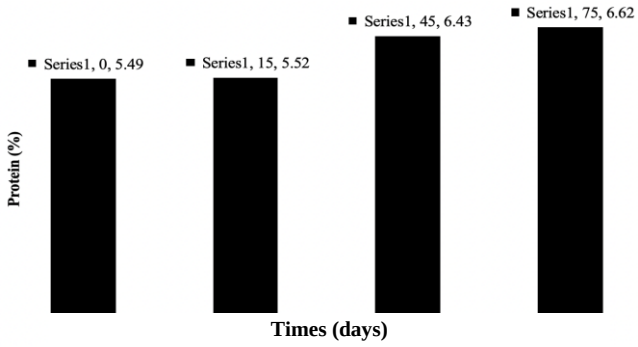

Figure 12. Protein content of decomposed *Rhizophora mucronata* leaf litter

In conclusion, this study showed that *R. mucronata* leaf litter had fungal diversity index value of 0.96, including relatively low species diversity. During decomposition, five species were identified namely *Aspergillus* sp. 1, *Aspergillus* sp. 2, *Aspergillus* sp. 3, *Penicillium* sp., *Trichoderma* sp. with decomposition rate (k) of 0.018/year. The rate of litter decomposition was strongly influenced by the initial organisms in the study location, namely the presence of *Nereis* sp. and Crustacea which shred litter from intact to decomposed form. Fragmentation caused by the activities of soil fauna, such as polychaeta (*Nereis* sp.), can increase the surface area of litter. The percentage of carbohydrate and protein content on days 0, 15, 45, and 75 was 10.40, 10.00, 9.23, and 7.69%, with protein content of 5.49, 5.52, 6.43, and 6.62%, respectively. Based on the results, further research should be conducted on *R. mucronata* leaf litter at salinity levels of 11-20 ppt and 21-30 ppt to observe the diversity of fungal species.

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