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To cite this article: R E Muliawan *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **429** 012057

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Productivity and decomposition rate of *Rhizophora mucronata* and *Avicennia alba* litter based on environment characteristics in Muara Gembong

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Abstract. Mangrove forests damage may decrease their function and ecological role in relation to litter production which support the sustenance of aquatic resources. This research aimed to determine and estimate productivity and decomposition rate of mangrove *Rhizophora mucronata* and *Avicennia alba* litter, and their effect on water nutrients. The research was conducted at three stations in Pantai Mekar Village, Muara Gembong District for 60 days observation during period of April–September 2018. Litter productivity was measured using litter traps and litter decomposition rate was estimated using litter bags. The concentration of water nutrient (nitrate, ammonium and phosphate) was obtained through a laboratory analysis. Litter productivity of *R. mucronata* and *A. alba* stands reached 4.68 and 7.11 g m⁻² day⁻¹ respectively with the biggest contributed from leaves litter. Observed different rates of mangrove decomposition was due to the lignin content. The decomposition rate of *R. mucronata* and *A. alba* were $Y=12.841e^{-0.382X}$ ($R^2=0.97$) and $Y=11.958e^{-0.478X}$ ($R^2=0.91$) respectively. The productivity and decomposition rate of *A. alba* litter was greater and faster than *R. mucronata*. Increased nitrates was indicated of nitrification process, while phosphate and ammonium showed decreased concentration during experiments. Aside from that, water nutrient concentration was affected by dissolved oxygen availability.

1. Introduction

Mangrove ecosystems besides having physical functions to preserve the coastal area from coastal water processes (tides, currents, waves, and hurricanes), it also has biological functions related to fisheries. Biologically, the mangrove ecosystem can be a nursery ground, spawning ground, and feeding ground of diverse types of fish and shrimp. Mangrove ecosystems also can supply major nutrients on the coast and the sea [1]. Mangrove forests can support life by decomposing leaves, stems, and flowers of mangrove plants by microorganisms and macro-organisms into detritus becomes a food source for fish, shrimps and crabs that suitable in an ecosystem [2]. Litter production is an important factor because it is a component of the food chain in mangrove ecosystems and not mangrove trees [3].

Mangrove forest litter has a function to maintain soil fertility. Soil and plant fertility depends on productivity and rate of litter decomposition [4]. According to [5] reports that one hectare of mangrove land can produce 7-8 tons of litter per year and that litter production increased water productivity around 20.8-25.0 tons C ha⁻¹ year⁻¹ [6] and fisheries production reaches Rp27 016 978 57 ha⁻¹ year⁻¹ [7].

Mangrove litter contains high levels of C (carbon), N (nitrogen), and P (phosphorus) elements and its can dissolved in water [8]. The elements released into the water is determined by the decomposition



process [9]. According to [10], the destruction (decomposition) of organic matter influenced by several factors are temperature, soil moisture, soil treatment, and pH. Mangrove ecosystem condition always moist and wet with high temperature throughout the year causes the litter decomposition process rapidly [11]. However, the rate of decomposition will run more slowly at low pH than high pH [12]. Decomposition is the process of dead-tree organic matter demolition that be carried out by biological and physical agents into mineral materials and organic colloidal humus. This process is a microbial (decomposer) process obtaining energy for propagation. Mangrove litter decomposition will enrich nutrients which then enter the food chain energy and energy flow system [13, 14]. Therefore, the decomposition of organic material (the mineralization process) that is running stable will maintain the nutrients supply (N and P) into the soil. If decomposition running slowly, nutrient availability will be decreased, especially P-element because it is least mount of availability, consequently affecting nutrient uptake and mangrove growth which will be inhibited [15, 10]. This study aims to estimate the production of *Rhizophora mucronata* and *Avicennia alba* organic compounds by determined the productivity and decomposition rate of mangrove litter, elemental nutrient release of C, N, and P from litters based on environment characteristics and their effect on water nutrients in Pantai Mekar Village, Sub-District of Muara Gembong.

2. Materials and metodhs

2.1. Time and location

This research was conducted at three stations representing the mangrove ecosystem in Pantai Mekar Village, Muara Gembong District, Bekasi Regency for 60 days observation during period of April-September 2018.

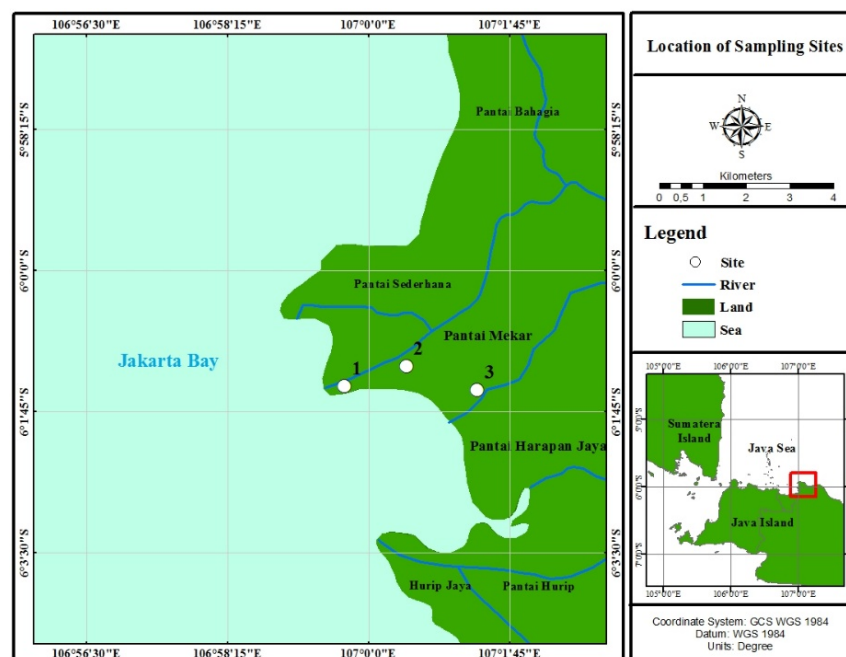


Figure 1. Location of sampling station.

2.2. Tools and materials

The tools was used in this study were Global Positioning System (GPS), refractometer, stationery, litter bag measuring 0.3 m x 0.3 cm with 1 mm mesh size, litter trap with 1 m x 1 m measurability and 1 mm

mesh size, analytical scale, oven, and plastic strap. The materials used are litter of *R. mucronata* and *A. alba* mangrove from the region Mangrove Pantai Mekar Village.

2.3. Procedures

2.3.1. Determination of station and research plots. Each research station was assigned three sampling plots with 10 m x 10 m measurability. Sampling plot points based on different types of vegetation using a zoning approach: the coastal zone, middle zone, and land zone respectively with the distance between sampling plots depending on the thickness of the mangrove at each observation station. The transect plot method were placed on the line transect by withdrawing the line transect from the sea toward the land [16]. This is intended to be able to compare differences in station locations to production, decomposition rates, and organic matter content from both litters observed of two types mangrove vegetation.

2.3.2. Litter production measurement. Sampling of mangrove litter production (leaves, fruit, flowers, and twigs) was determined by using a nets measuring 1 m x 1 m. Storage nets were installed in tree per observation plot and placed under the canopy of mangrove trees about 1–1.5 meters above the ground level. This aim to prevent the influence of tidal water and determine the amount of litter production that fall into the ground surface of mangrove ecosystem. Litter production measurements were carried out for four times with collecting period of 7 days. Litter falls in the trap were taken and separated based on the leaves, fruits, flowers, and twigs. The collected litters was dried using an oven at 105 °C until reaches a steady weight [17].

2.3.3. Litter decomposition rate measurement. Decomposition rate measured by placing the dried leaf litter as much as 10 g of dry weight into a litter bag measuring 30 cm x 30 cm with a 1 mm mesh size (Ashton *et al.* 1999). Amount 5 litter bags were placed in each sampling plot. Litter bags were placed on the soil surface and tied to the mangroves roots so as not to be carried by the tides. Litter bags were taken from each sampling plot per 15 days for 60 days of observation. Leaf litter samples that have been taken were cleaned from the mud then dried at 105 °C until the weight is constant [17].

2.3.4. Nutrient production measurement. The dried leaf litter (10 g) placed in the test container (25 x 25 x 30) cm which had been given 3 liters of substrate and 10 liters of sea water to measure nutrients (nitrate, phosphate and ammonium) in water at intervals during 15, 30, 45, 60th days observation. Analysis of water quality such as salinity, temperature, pH and dissolved oxygen (DO) was carried out to determine its effect on nutrient production. This experiment used water and sediment samples from the study site.

2.4. Analysis procedures

2.4.1. Leaf litter nutrient content. The dried litter samples were measured for lignin content and C-organic nutrients by the LOI (Loss on Ignition) method, N-total used the Kjeldahl method and P-total measured by wet ashing method. In addition, lignin content in litter measured by using the Van Soest method to see the structure of leaf litter composition.

2.4.2. Water nutrient compound. Water samples taken from the study site and retested of nutrients such as ammonium, orthophosphate and nitrates using [18] by the principle of spectrophotometer with wavelength of nutrient 640 nm, 543 nm, 885 nm respectively.

2.4.3. Mangrove vegetation. Analysis of mangrove vegetation data includes Species Density (D_i) where D_i is the number of individual species founded in an area [3]

$$D_i = \frac{n_i}{A} \quad (1)$$

Where D_i is mangroves density (ind/100 m²), n_i is number of individuals observed (ind), A is plot area (100 m²).

2.4.4. Litter decomposition rate. The litter decomposition rate is calculated based on the dry weight data of litter samples which was obtained every 15 days. The litter decomposition rate is calculated using the formula [17]:

$$X_t = X_0 e^{-kt} \quad (2)$$

Where X_t is litter dry weight after observation (g), X_0 is initial litter dry weight (g), e is natural logarithm number (2.72), k is the litter decomposition rate constant, and t is observation time (per day)

The half-life ($t_{1/2}$) of mangrove leaves litter decomposition is calculated based of the formula [17]:

$$t_{1/2} = \frac{\ln 2}{k} \quad (3)$$

Where $t_{1/2}$ is initial time needed to decompose half of the litters weight (day) and k is the litter decomposition rate constant.

2.4.5. Nutrients released. The C-organic, nitrogen and phosphorus nutrients released into the waters is calculated using the formula [19].

$$N_t = (W_0 \times N_0) - (W_t \times N_t) \quad (4)$$

Where N_t is nutrient content released (g per day), W_0 is initial litter dry weight (g), W_t is litter residual dry weight after day observation (g), N_0 is initial nutrient content (g), and N_t is residual nutrient content after day observation (g).

2.4.6. The relationship between water quality characteristics and nutrient production. The relationship between water quality characteristics and organic material production was obtained using Principal Component Analysis [16] using the XLSTAT 2016. Software. This was analyzed to explain the effect of water quality parameters on nutrient production of each type of mangrove litter species observed in various observation times.

3. Result and discussion

3.1. Mangrove litter production and productivity

Percentage of each component of litter drop generated at Muara Gembong has a lower value than [20], the litter drop of each component of leaves, fruit/flowers, and related twigs by 76%, 22%, and 2 % respectively for *R. mucronata*. The high percentage of *R. mucronata* leaf litter production by the tree density level of 21 ind/100 m² was higher than *A. alba* stands of 15 ind/100 m² at the study site. The level of litter productivity depends on plant species, stand density, biomass from various parts of the tree, and seasonal conditions [21]. Mangrove leaf litter production will increase with the high density of mangrove trees in forest areas [22].

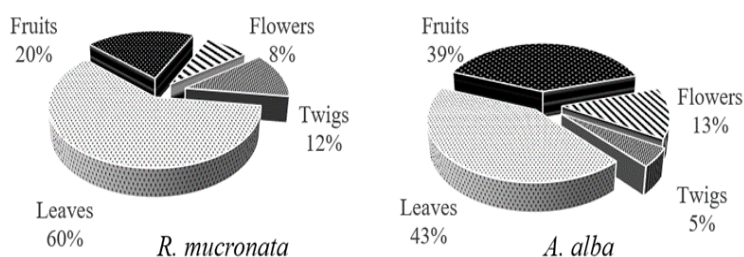


Figure 2. Litter production percentage (leaves, fruits, flowers, and twigs) from both mangrove species in Muara Gembong.

The observation period of mangrove litter productivity during the study took place in the North-West Monsoon (June – August) (Table 1). In the dry season will produce more litter drop than the rainy season [21]. The state of this season also affects plant phenology. [21] Conducted a study related to the phenology of *R. mucronata* mangrove species reaching the peak of reproductive organ maturity on average in March to August, while *A. alba* getting matured in June-September. The differences value indicated to be influenced by the relationship between sampling time and maturity of the reproductive organs (fruits and flowers) that become litter and affected the percentage of production and productivity of *A. alba* litter and flowers more than *R. mucronata* during the observation period. Litter production released will fall to the floor of the mangrove ecosystem and will undergo a process of washing by tides and currents.

Table 1. Litter production each specieses ($\text{g m}^{-2} \text{day}^{-1}$) in site study.

Species	Litter productivity ($\text{g m}^{-2} \text{day}^{-1}$)			
	Leaves	Fruits	Flowers	Twigs
<i>R. mucronata</i>	2.969 ± 0.21	0.804 ± 0.16	0.294 ± 0.09	0.619 ± 0.21
<i>A. alba</i>	3.172 ± 0.65	2.591 ± 1.18	0.983 ± 0.13	0.364 ± 0.06

Family of Rhizophoraceae has a higher level of productivity compared to other species. Mangrove litter production of *R. mucronata* species averaged 2.1 g day^{-1} per tree [23], while [24] reported *A. alba* litter production average of $4.217 \text{ g m}^{-2} \text{days}^{-1}$ (figure 3) As the results of station points on Table 1 shows the high litters productivity at Station 1, salinity values approximately 30.0–31.0 ‰, occurs of each species has around of $5.73 \text{ g m}^{-2} \text{days}^{-1}$ (*R. mucronata*) and $8.39 \text{ g m}^{-2} \text{days}^{-1}$ (*A. alba*) respectively. The high value of productivity is related to carrying capacity of water environments quality instances salinity as a form of adaptation of mangrove plants in the waters. At extreme salinity, the tree would grow stunted and lost the ability to produce fruit [25]. Mangroves would accumulate excess salt in the bark of trees and old leaves and then aborted [26].

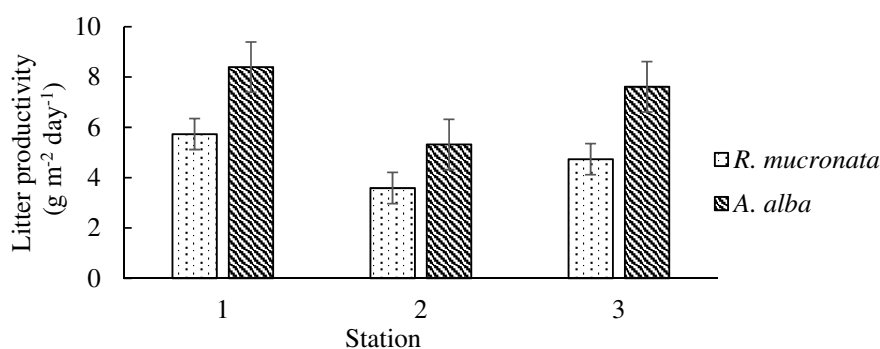
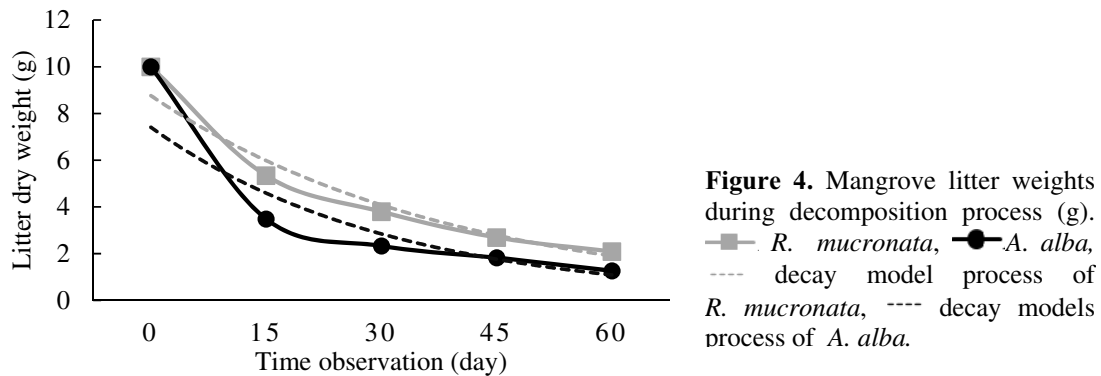


Figure 3. Litter productivity ($\text{g m}^{-2} \text{day}^{-1}$).

3.2. Litter decomposition

Based on the results, the remaining weight of leaf litter *R. mucronata* and *A. alba* during the observation period (60 days) were 20.30% and 12.66%, respectively. The relationship between observation period with percentage of litter residual weight in this study was shown from the determination coefficient (R^2) of *R. mucronata* and *A. alba* species is 0.97 and 0.91 respectively (figure 4). The decomposition process would take rapid pace at the beginning of the observation process. The leaching process of organic matter contained in leaf biomass will take place more slowly as the length of time of observation [27]. This is characterized by a half-life (t_{50}) of both *R. mucronata* species for 27 days and *A. alba* species for 20 days.



The leaf litter decomposition rate of *R. mucronata* and *A. alba* species during study observations showed values of 0.026 and 0.034 respectively. The decomposition process that occurs in the leaf litter of *A. alba* is faster than *R. mucronata*. Based on these values, the decomposition rate of *R. mucronata* litters shows a smaller value than the results reported by [28] which is 0.035 and species of *A. alba* show the same value as reported by [29], which is 0.34. The quality of physical and chemical properties on litter compounds influenced this condition. The small and thin morphology of *A. alba* leaves allows for better decomposition. In addition, one leaf composition that can affected the rate of decomposition is lignin content [30]. The large lignin content will inhibit the decomposition process because lignin, complex compound, is arduous to decompose by decomposer microorganisms. The lignin content in both litters showed the value of *R. mucronata* leaf litter was 31.02% greater than *A. alba* which was 27.81% (Table 2). The percentage of lignin content confirms that the decomposition rate of *R. mucronata* leaf litter is lower than *A. alba* species. High lignin content will cause the decomposition process to run slower [31].

Table 2. Litter decay constants value (per day) in study site.

Species	Decay equation (per day)	R ²	Decay constant (per day)	Half-life ($t_{1/2}$) days
<i>R. mucronata</i>	$Y = 12.841e^{-0.382X}$	0.97	0.026	27
<i>A. alba</i>	$Y = 11.958e^{-0.478X}$	0.91	0.034	20

3.3. Discharge ratio for Carbon, Nitrogen, and Phosphorus mangrove litter

The nutritional value of the leaves as several factors influenced the decomposition process. Nutritional value can be seen based on the rate ratio of C, N and P contained in leaves [32]. The C/N ratio during the decomposition process decreased after day 15 observation (figure 5a). The increased C/N ratio in initial period of decomposition process indicates the N immobilization process takes place in the decomposition process [33]. It is suspected that there is a mineralization process that produces reactive and phenolic carbohydrate compounds [30]. A high C/N ratio (low N concentration) in litter during the decomposition process will result in a slower rate of decomposition [27]. The decomposition process will run slowly when the concentration of N is small [34]. In addition, N content release in this study showed a greater value until the end of the observation, characterized by a low C/N ratio. The activity of microorganisms that are able to fix nitrogen influenced this condition [35] and the binding of free nitrogen in the atmosphere at low tide. The results of the decomposition process N from organic matter will be released into the waters as turn out of mineralization process [34].

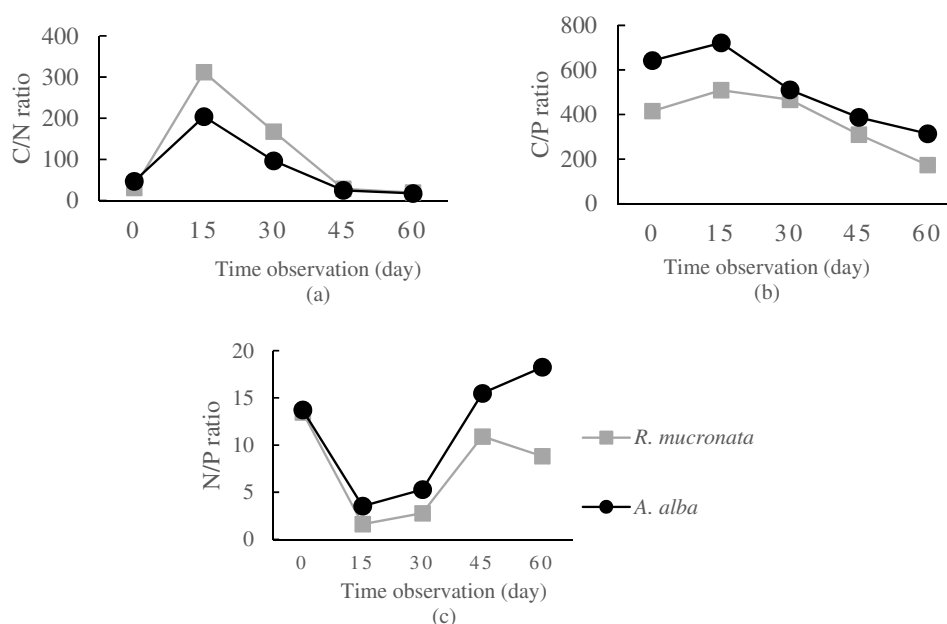


Figure 5. Litter nutrients content ratio release during decomposition process, (a) C/N elements; (b) C/P element; (c) N/P elements.

As the observed results, the C/N and C/P ratios indicate the C-organic concentration released tends to decrease with the length of the decomposition process. The C-organic content in mangrove leaf litter will decrease with litter particles size decreasing [36]. The C-organic concentration released has not been able to explain the value of the decomposition rate because litter has other components such as lignin and cellulose which can affect slow down the process of washing leaf litter. The C-organic content released during the research process shows a lower value towards station one due to influenced by the salinity level at the area. The C-organic element at a smaller salinity will be increasingly released into the mangrove ecosystem [37]. C-organic content diminish during decomposition process as an impact of non-structural carbohydrates released such as sugars and starches which are utilized by microbes in small concentrations during the decomposition process [38].

P-elements litters release during the decomposition process is relatively less than the N-element percentage. The phosphate content in plants is unstatic because phosphate will be allocated to the active tissue so that the older tissue (litter that will fall) contains a small phosphate. The N/P ratio (figure 5c) shows tend to increase with the length of the decomposition process which appears approximately 1.63-15.48. A large N/P ratio (high N content) indicates that the degradation of dissolved P elements occurs through the washing process [38]. Also, the N/P ratio until the end of the observation tends to be following the results reported by [39] which is value <30 . The degradation of element P is indicating relatively faster instead of C and N elements during the decomposition process. Aside from that, mangrove litter have changes while the composition of nutrient content due to ongoing microorganism processes. The C-organic content in leaves litter is greater than the N and P elements content [40]. These N and P content concentration would increase continually related to microbial colonization which was develop the nutritional qualities of leaves for detritivore [41].

3.4. Carbon, Nitrogen, and Phosphorus elements potential productivity of mangrove litter

The potential release of organic C-litter each was $0.22 \pm 0.024 \text{ g C m}^{-2} \text{ days}^{-1}$ or $811,044 \pm 88.33 \text{ kg C ha}^{-1} \text{ year}^{-1}$ for *R. mucronata* and $0.25 \pm 0.043 \text{ g C m}^{-2} \text{ days}^{-1}$ or $921.16 \pm 156.77 \text{ kg C ha}^{-1} \text{ year}^{-1}$ for *A. alba*. The total C-organic released from *R. mucronata* litter is smaller than reported by [8] reached 25,121-ton C year^{-1} and $0.528 \text{ g C m}^{-2} \text{ day}^{-1}$ for *A. alba* species [42]. The C-organic content released

during the decomposition process shows the relationship between litter production amount at each station and it caused of the high release of C-organic from *A. alba* species. The C-organic content released in the waters will become a carbon source that can determine the rotation of organic material at the ecosystem level through fixation by phytoplankton and the ecological function of the mangrove ecosystem as carbon sequestration will store carbon in sediments.

The average amount of N and P nutrient release from *R. mucronata* and *A. alba* leaf litter at the study location were 0.007 ± 0.0008 g N m⁻² day⁻¹ or 27.17 ± 3.03 kg N ha⁻¹ year⁻¹ and 0.0009 ± 0.0001 g P m⁻² day⁻¹ or 3.26 ± 0.53 kg P ha⁻¹ year⁻¹ for the *R. mucronata* species, and 0.004 ± 0.0004 g N m⁻² day⁻¹ or 15.34 ± 1.53 kg N ha⁻¹ year⁻¹ and 0.0004 ± 0.0001 g P m⁻² day⁻¹ or 1.39 ± 0.49 kg P ha⁻¹ year⁻¹ for species *A. alba*. This value is lower than that reported by [20] for *R. mucronata* reached 131.4 kg N ha⁻¹ per year and 13.14 kg P ha⁻¹ per year. Nutrients N and P released by *R. mucronata* are more numerous than *A. alba* species. This difference is due to *R. mucronata* leaf litter containing more organic matter although *A. alba* litter productivity is more than *R. mucronata*. The nutrients released later will be the energy potential for phytoplankton growth and electron transport in photosynthesis. Based on the content of these potential nutrients, mangrove litter produced can support the existence of mangrove ecosystems and the ecological function of mangroves as contributors of nutrients in research site related to economic functions of silvofishery activities that can be utilized sustainably.

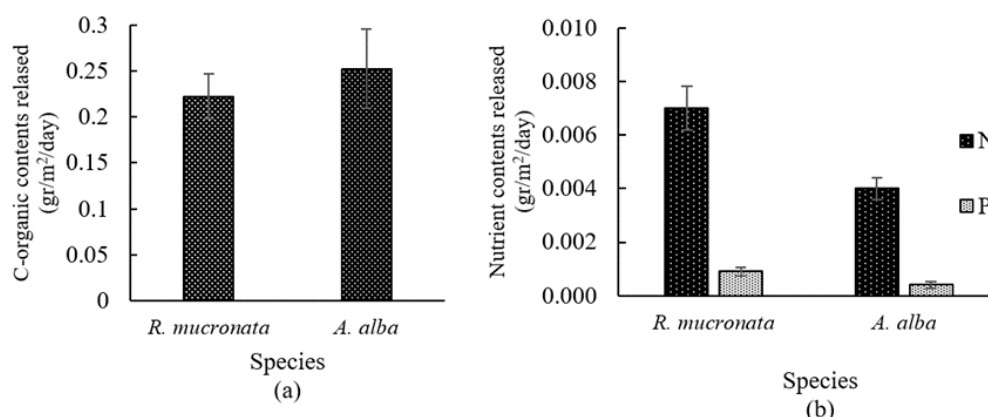


Figure 6. Organic matter potential released, (a) C (gr/m²/day); (b) N and P (gr/m²/day) of *R. mucronata* and *A. alba* litter.

3.5. Environmental data

Based on the analysis results in Table 3, the temperature has a range of 28.0–32.0 °C. The optimum temperature of the decomposer (bacterium) in the decomposition process assuming mangrove leaves as metabolic material ranges from around 27.0–36.0 °C [43]. In addition, DO content which has a range of around 3.78–4.89 mg L⁻¹ indicates that there is an influence of the process of littering in mangrove areas by decomposers that need oxygen [42]. In addition, the low DO level indicates that a significant process of organic matter decomposition occurs [44] and the existing DO is used for the respiration process [45]. The pH values results in Table 3 showed that Station 2 obtained the highest pH values, which is 7.66. The decomposition process of organic matter by microorganisms rapidly under neutral and alkaline pH conditions [34]. The decomposition process of mangrove litter affects acidic water conditions [42] because accumulated organic matter process will release H⁺ ions which will affect the pH of the water [44]. Based on the salinity values obtained, the highest value at Station 1 is 30.0–31.0 ‰. This is linear with high litter productivity at Station 1. The percentage of leaves litter drop is correlated positively with the salinity level of mangrove ecosystem waters, which the higher of waters salinity cause high production of mangrove litters [23].

Table 3. Water quality parameters in each sampling station.

Water Quality Parameters	Sampling Station		
	1	2	3
Temperature (°C)	30.0–32.0	31.0–32.0	28.0–30.0
Salinity (‰)	30.0–31.0	27.0–28.0	25.0–26.0
Dissolved oxygen (mg L ⁻¹)	3.78	4.48	4.89
pH	7.40	7.66	7.36

3.6. Nutrient content in water during the decomposition process

Nitrate content in water samples increased compared to observational controls. The nitrate increased content occurred until the 30th day observation. The highest increasing in samples with *A. alba* leaf litter approximately from 0.034 mg L⁻¹ increased to 0.237 mg L⁻¹ compared to samples with *R. mucronata* only 0.174 mg L⁻¹. Furthermore, nitrate content began to decrease with increasing time of observation until the 60th day observation. Ammonium content decreased until the 45th day observation. In ponds with *A. alba* litter decreased from 0.984 mg L⁻¹ to 0.058 (on the 45th day observation) compared to ponds with litter *R. mucronata* out of 0.035 mg L⁻¹. Degradation of nitrogen content related to the length of time nitrogen particles decompose. The degradation will increase the ammonium content at the time of initial observation. The highest orthophosphate content from both treatments showed level range of 0.965 mg L⁻¹ (*A. alba*) and 0.486 mg L⁻¹ (*R. mucronata*) respectively. Decomposes of phosphate from particulate form indicated decreasing of orthophosphate content. The phosphate continues to be utilized until its existence becomes thinner and even growth slows. In addition, phosphate in water will be utilized through the process of photosynthesis.

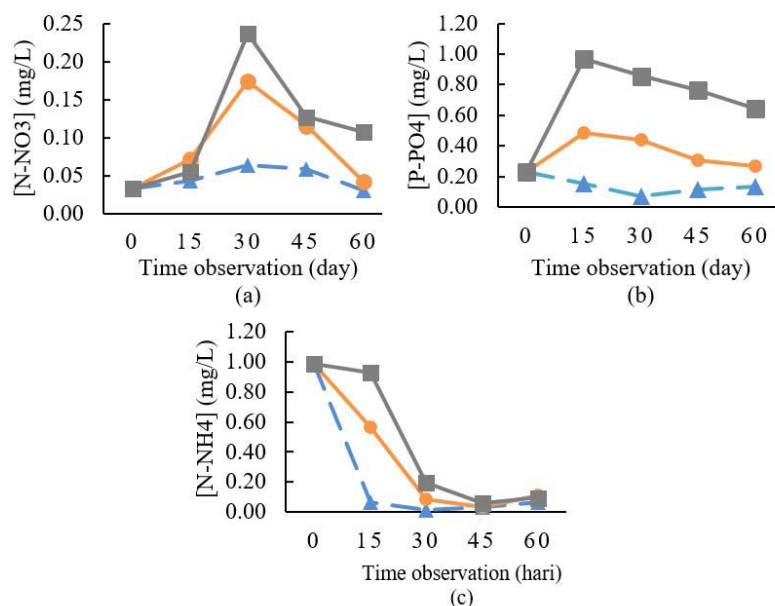


Figure 7. Water nutrients concentration (mg/L) during observation, (a) nitrate; (b) orthophosphate; (c) ammonium. Control, *R. mucronata*, *A. alba*.

Mangrove leaf litter thought to be able to improve the process of aquatic enrichment. Plant tissue containing nitrogen during the decomposition process will be converted into organic nitrogen particles and dissolved due to microorganism activity. Degradation of nitrogen content related to the length of time nitrogen particles decompose and increased the ammonium content at the time of initial

observation. The availability of oxygen in the water observed greatly influences the existence of the nitrogen cycle. Nitrification process come off during the observation indicated by decreasing ammonium concentration along increasing nitrates content. The nitrification process is influenced by several parameters ie temperature, dissolved oxygen, and pH. Ammonium oxidation to nitrate through nitrification process occurs on days 8 to 10 and runs optimally at pH 8.0 [34]. This is supported by the results of pH measurements during observations ranging from 7.60-7.77. The DO content measured during the observation shows values in the range of 2.5–5.5 mg L⁻¹. The dissolved oxygen levels <2 mg L⁻¹ will causing the nitrification process to run slower. In addition, the temperature measured during observation shows values ranging from 24.8-27.0 °C. The nitrification speed process runs slowly when the measured temperature is more or less in the temperature range of 20-25 °C [34].

3.7. Relation of characteristics of water quality with nutrient production

The ponds experiments each time repetition and experiments with water quality parameters (Temperature, dissolved oxygen, salinity and pH) which using Principal Component Analysis (PCA) tools (figure 8), shows Axis 1 (F1) explains the diversity of data of 41.04% which is characterized by experiments K0, R0, and A0 with high DO. The analysis showed that at the beginning of the observation both in the control pond (K0) and both of mangrove litter (R0 and A0), DO parameter variables tended to influence the nutrient content produced. In addition, the R30, A30, A45, and A60 ponds are characterized by the dominant orthophosphate and nitrate content variables. The content of orthophosphate and nitrate by giving *R. mucronata* litter showed a high value on the 30th day while *A. alba* litter showed a significant decrease in content as the length of time of observation after the 30th day. The high DO content at the beginning of the observation then decreases with time, because the pond is not given aeration so that oxygen is increasingly used by microorganisms to carry out metabolism. The less nitrate content is indicated to have been a reduction process to ammonium in the experimental system.

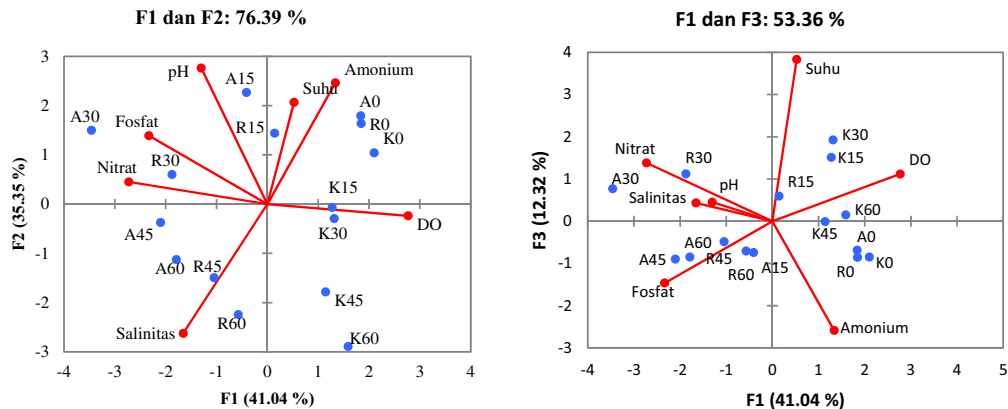


Figure 8. Results of principal component analysis

Axis 2 (F2) explains the diversity of data of 35.35% which is characterized by variable ammonium content and pH at the 15th day observations (A15 and R15) in both treatments. Variable salinity values at 45 days and 60 days showed a significant increase in ponds with *R. mucronata* mangrove litter (R45 and R60). Increasing salinity of seawater will reduce the percentage of ammonium that is not ionized. Increasing the ammonium in a waters is influenced by the pH value. The percentage of ammonium increases with increasing pH and water temperature [34].

Axis 3 (F3) explains the diversity of 12.31% which is characterized by temperature variables on control observations on the 15th and 30th days. Observations made in a closed room because the temperature has a value that tends to be homogeneous excess influences of litter decomposition process. [46] Explain that the sensitivity of environmental temperatures during the decomposition process affects the carbon sequestration process in warmer ecosystems. In addition, the increase in temperature is also

able to stimulate the decomposition process to be better for the activities of the decomposer community [47].

As the results of PCA techniques analysis, the dissolved oxygen concentration will affect the content of nitrate and phosphate values during the study. In addition, pH and salinity values were related to changes in ammonium content, while the measured temperature content generally affected all experiments. The less nitrate content is indicated to have been a reduction process to ammonium along of dissolved oxygen concentration diminished in the experimental systems. Increasing the waters ammonium rate was influenced by the pH value. The percentage of free ammonium increases with increasing pH and water temperature [34]. The increase in temperature is also able to stimulate the decomposition process to be better for the activities of the decomposer community

4. Conclusion

The productivity of *A. alba* litter is outnumbered *R. mucronata* which is dominated by leaves. *R. mucronata* leaves are rapidly decomposed than *A. alba* due to it has more lignin content as a factor. During the decomposition process, the C: N: P ratio shows that P nutrient degradation is faster than C and N. In addition, *A. alba* litter has the potential to release more C nutrients, whereas *R. mucronata* litter releases more N and P content. In addition, nutrient content such as orthophosphate, ammonium and nitrate decreases. This is influenced by temperature, salinity, DO and pH.

5. Recommendation

Need to do more longer temporal observations to estimate the rate of decomposition of all litter components so that they are completely decomposed to recapitulate expected of organic matter release from litter is better.

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