Jurnal Perikanan
Fisheries Journal, 14 (2), 417-427 (2024)
http://doi.org/10.29303/jp.v14i2.803

NUTRITIONAL CONTENT IN THE LEAVES AND RHYZOMES OF *ENHALUS ACOROIDES* ON BADAK-BADAK ISLAND, BONTANG CITY, EAST KALIMANTAN

Kandungan Gizi Pada Daun dan Rizoma Enhalus Acoroides di Pulau Badak-Badak, Kota Bontang, Kalimantan Timur

Muhammad Fahrul Rizal Setiawan[1], Lily Inderia Sari[1], Aditya Irawan[1*]

[1]Fisheries Resource Management Department, Mulawarman University

Gunung Tabur Street, Gunung Kelua College, Samarinda 75119, East Kalimantan

*Koresponding author: aditya.irawan@fpik.unmul.ac.id

(Received February 12th 2024; Accepted March 30th 2024)

ABSTRACT

Enhalus acoroides contributes greatly to the seagrass ecosystem and has the largest morphology among other seagrass species and consistently supplies important nutrients in coastal areas. The research aims to determine the nutritional content in the leaves and rhizomes of *E. acoroides* from Badak Badak Island, Bontang City. This research was carried out from July 2023 - February 2024. The research station consists of 3 stations, namely AU Station representing the Northern part of the seagrass meadow, BT Station representing the Eastern part and CB Station representing the Western part. The analysis of nutritional content uses proximate test analysis in the form of ash, fat, protein and carbohydrate content. The distribution characteristics of water quality and basic substrate based on stations used the Principal Component Analysis approach. The substrate texture at Stations AU and BT is clayey sand, while Station CB is sandy loam. The ash content in the rhizomes is lower than in the leaves with a ratio of 1:1.36. The lipid content in rhizomes is lower than in leaves with a ratio of 1:1.23. The protein content in rhizomes is lower than in leaves with a ratio of 1:1.23. The carbohydrate content in leaves is lower than in rhizomes with a ratio of 1:1.17.

Keywords: Leaf, *Enhalus acoroides*, Nutrition, Rhizome

ABSTRAK

Enhalus acoroides berkontribusi besar pada ekosistem padang lamun dan memiliki morfologi paling besar diantara spesies lamun lainnya dan secara konsisten menyuplai nutrisi penting di wilayah pesisir. Penelitian bertujuan untuk mengetahui kandungan gizi di daun dan rizoma *Enhalus acoroides* dari Pulau Badak Badak Kota Bontang. Penelitian ini dilaksanakan mulai Juli 2023 – Februari 2024. Stasiun penelitian terdiri dari 3 Stasiun yaitu Stasiun AU mewakili padang lamun bagian Utara, Stasiun BT mewakili bagian Timur dan Stasiun CB mewakili bagian Barat. Analisis kandungan gizi menggunakan analisis uji proksimat berupa kadar abu, lemak, protein dan karbohidrat. Karakteristik sebaran kualitas air dan substrat dasar berdasarkan stasiun digunakan pendekatam *Principal Component Analisis.* Tekstur substrat dasar di Stasiun AU dan BT pasir berlempung sedangkan Stasiun CB lempung berpasir. Kadar abu di rizoma lebih rendah daripada di daun dengan rasio 1:1,36. Kandungan lemak di rizoma lebih rendah daripada di daun dengan rasio 1:1,23. Kandungan protein di rizoma lebih rendah daripada di daun dengan rasio 1:1,23. Kandungan karbohidrat di daun lebih rendah daripada di rizoma dengan rasio 1:1,17.

Kata Kunci: Daun*,* *Enhalus acoroides*, Gizi, Rizoma

INTRODUCTION

Seagrass ecosystems has an important role in ecological functions, especially maintaining the survival of various biota in the Indonesian coastal-marine ecoregion (Kawaroe *et al.,* 2016). Seagrass beds has a high biological productivity (Rosalina *et al.,* 2022). Seagrass beds contribute to the availability of nutrients and other ecosystem services in coastal environments (Muzani *et al.,* 2020; Lima *et al.,* 2023).

Seagrass physically consists of roots, rhizomes and leaves (den Hartog, 1970; Thomlinson, 1974) which are micro-habitats for periphyton (Rina *et al.,* 2019). Enhalus acoroides is one of 12 species found in Indonesia (Tomascik *et al.,* 1997), this species can be found on substrates with gravel and silt fractions (Rahmadani *et al.,* 2023), has a larger morphology (Lestari *et al.,* 2020) and has a wider habitat niche than other seagrass species (Rina *et al.,* 2019) and tends to has the highest importance value index, especially in the P. Lembeh seagrass beds with a range of 231-300% (Rustam *et al.,* 2015) and is the dominant species found in the coastal waters of Bontang City (Irawan *et al.,* 2021).

The important role of E. acoroides, especially in the fruit (Ratnawati *et al.,* 2018), rhizomes and seeds are used as food by the people of Lomin Seram Village (Wakano, 2013) and the people of Sowek Village, Sopiori Regency, Papua Province (Kaya, 2017) and has the potential to act as an anti- bacteria, anti-aging, antiviral, antitumor and anti-oxidant (Ismarti & Amelia, 2023) as well as potential as a phytochemical (Windyaswari et al., 2019). Naturally it is food for turtles, dugongs (Warsidah *et al.,* 2023) and fish from the Scaridae family (Miftahudin *et al.,* 2020).

The nutritional content of the rhizomes and seeds of E. acoroides in the seagrass beds of Sowek Village tends to be higher in the rhizomes than in the seeds with a carbohydrate ratio of 1:1.29, protein 1:1.10 and fat 1:1.11 (Kaya, 2017). Proximate tests on fruit from Samboang Beach showed that the carbohydrate content reached 10.38%, protein 1.2% and fat 0.66% (Minsas, 2023) and Tahril (2010) reported the protein content of E. acoroides in Regency Beach Donggala reached 6.2%.

The large contribution of E. acoroides to the seagrass ecosystem which has the largest morphology among other seagrass species and consistently supplies important nutrients in coastal areas and there is still limited information regarding the nutritional content of E. acoroides by region, therefore, a study of the nutritional content in the leaves and rhizomes of E. acoroides on Badak Badak Island, Bontang City, East Kalimantan, is important as an effort to manage integrated and sustainable coastal ecosystems.

METHODS

Time and Place of Research

This research was carried out from July 2023 – February 2024 in the seagrass beds of Badak-Badak Island, Bontang City, East Kalimantan (Figure 1). Proximate analysis (moisture content, ash content, fat, protein and carbohydrate content) was carried out at the East Kalimantan Agricultural Instrument Standards Implementation Laboratory (BPSIP). Water quality analysis was carried out at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences, Mulawarman University and basic substrate analysis was carried out at the Soil Laboratory, Faculty of Forestry, Mulawarman University.

Research Station

The research station consists of 3 stations, namely Station AU representing the northern seagrass beds, Station BT representing the eastern seagrass beds and Station CB representing the western seagrass beds (Figure 1).

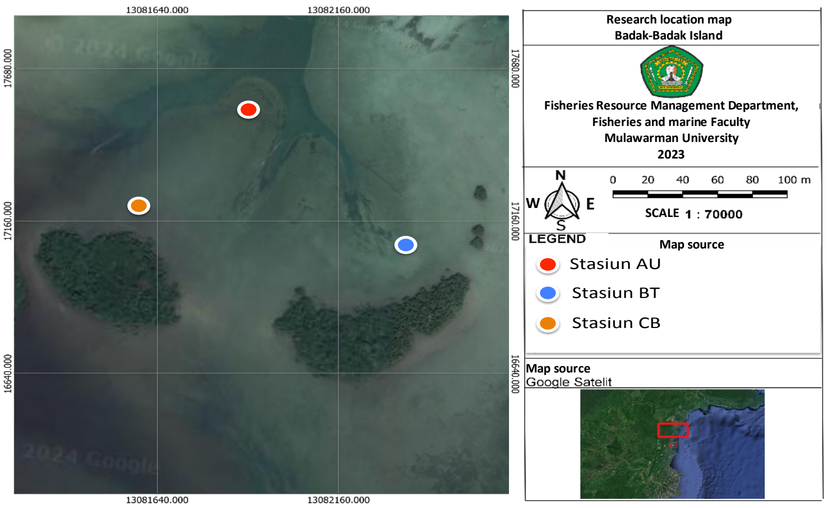

Figure 1. Research Location map

Research Parameters and Sampling Techniques

Enhalus acoroides

The *E. acoroides* variable measured was the number of stands area using a 50 x 50 cm square frame (English *et al.,* 1994) with the line transect method and a distance between square frames are 100-150m. Sampling to measure carbohydrate, protein and fat content in leaves and rhizomes was carried out compositely at each transect at each station.

Proximate analysis of *E. acoroides* leaves and rhizomes (water content, ash content, fat content, protein, carbohydrates) (Table 1).

Table 1. Proximate Analysis Tools and Materials

Analysis	Tool	Material	Method
Moisture Content	Ovens, porcelain dishes, desiccators, analytical balances, clamps	Sample	Gravimetric
Ash Content	Porcelain crucibles, ashing furnaces, desiccators, analytical balances	Sample	Gravimetric
Lipid	Soxhlet apparatus, special flask for fat, oven, water bath, analytical balance, desiccator, clamp, filter paper, thread	Sample, Petroleum Benzine	Soxhlet
Protein	Analytical balance, distillation flask (250 ml), measuring cup (25 ml, 50 ml), Distillation apparatus,	Sample, H_2SO_4, catalisator, aquadest, NaOH 50%, HCL,	Kjedhal

Analysis	Tool	Material	Method
	5 ml volume pipette, Kjedhal flask, Erlenmeyer	boiling, chips, HB^3O^3, mixed indicator	
Carbohidrat	Moisture + Ash + Fat + Protein	Sample	By different

Physico-Chemical Parameters of Water and Substrate

Water quality variables were measured during high tide with 3 repetitions including: temperature, turbidity, current speed, salinity, pH, dissolved oxygen carried out in situ using a Water Checker. Nitrate and phosphate were analyzed in the laboratory. Measurement of basic substrate variables includes clay fraction, dust, coarse sand, medium sand, fine sand, total sand, and texture. Composite basic substrate sampling at each transect at each station. Sample analysis is carried out in the laboratory. Determination of sea water quality standards is based on Attachment VIII to Indonesian Government Regulation No. 22/2021 concerning Implementation of Environmental Protection and Management.

Data Analysis

Absolute Density and Relative Density

The absolute density of seagrass species is the total number of individuals in a unit area (English et al., 1994), namely: $K_i = N_i/A$. Note: Ki = absolute density of species i (stands/m^2); n_i = total number of individuals of species i (stand); A = total sampling area (m^2). The relative density of seagrass is the ratio of the absolute density of the ith species and the sum of the densities of all species (English et al. 1994), namely: $KR_i = (K_i / \sum K)$. Note: KR = relative density of the i-th species; n_i = absolute density of the i^{th} species; $\sum K$= total density of all species.

Closure and Relative Closure

Calculation of seagrass species cover based on English *et al.,* (1994), namely: $P_i = \sum (M_i \times f_i) / \sum f_i$. Note: P_i = closure of the ith species; M_i = mean percent value of the ith class; f_i = frequency (number of sectors with some class i); $\sum f_i$ = total frequency of the ith species. The relative cover of seagrass species is the ratio between the cover of the ith species and the total cover of all species, namely: $PR_i = (P_i / \sum F)$. Note: PR_i = relative cover of species i; P_i = cover of the ith species; $\sum F$ = cover of the i^{th} species.

Distribution of Physico-Chemical Characteristics of Water and Substrate

To determine the distribution of physico-chemical characteristics of water and basic substrate between research stations, a multi-variable statistical analysis approach based on Principal Component Analysis (PCA) was used. Principal Component Analysis is not realized from initial parameter values, and synthetic indices are obtained from a linear combination of initial parameter values (Ludwig & Reynolds, 1988; Legendre & Legendre, 1998; Bengen, 2000; Kusumaningtyas *et al.,* 2023).

Centering is obtained from the difference between the initial parameter value and the average parameter value, namely: $C_{ij} = X_{ij} - X_i$. Note: C_{ij} = centralization value; X_{ij} = initial parameter value; X_i = average value of the parameter. Reduction is the quotient between the parameter value that has been centered and the standard deviation value of the parameter, namely: $R_{ij} = C_{ij} / Sd_{ij}$. Description: R_{ij} = reduction value; C_{ij} = centralization value; Sd_{ij} = parameter standard deviation value. The Euclidean distance is based on the formula (Legendre & Legendre, 1998), namely: $d^2(i,i') = \Sigma (x_{ij} / x_i - x_{i'j})$. Note: d = Euclidean distance; i,i' = two stations (on a line); j = physico-chemical parameters of water or sediment (in columns, varies from 1 to p. The smaller the Euclidean distance between two research stations, the more similar the physico-chemical characteristics of the waters and bottom substrate between the two stations.

RESULT

Basic Physico-Chemical Parameters of Water and Substrate

The results of measurements of physico-chemical parameters and basic substrates are presented in Figure 2, Figure 3 and Figure 4. Based on Figure 2, it shows the physical parameters which include temperature on average 30.2oC, turbidity range of 6.95-7.03 NTU and current speed ranges from 0.23-0.56 m/sec. Based on Figure 3, it shows chemical parameters which include salinity ranging from 31-31.1‰, pH ranging from 8.1-8.2, DO content ranging from 6.82-7.42 mg/L, and nitrate ranging from 0.039-0.042 mg/L. , and phosphate ranging from 0.003-0.006 mg/L. Based on Figure 4, it shows that the texture type at AU Station and BT Station is clayey sand and CB Station has a sandy clay texture.

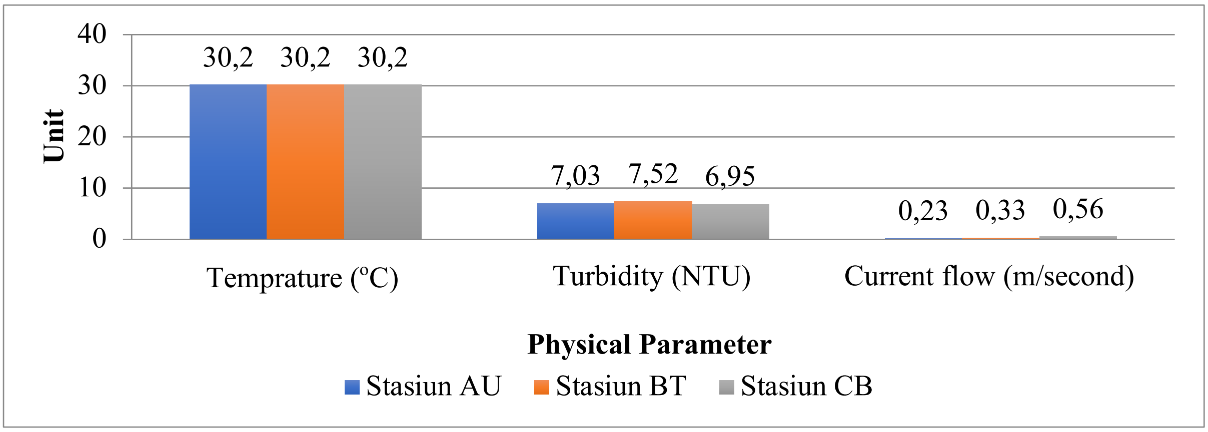

Figure 2. Results of Water Physical Parameter Measurement Based on Station

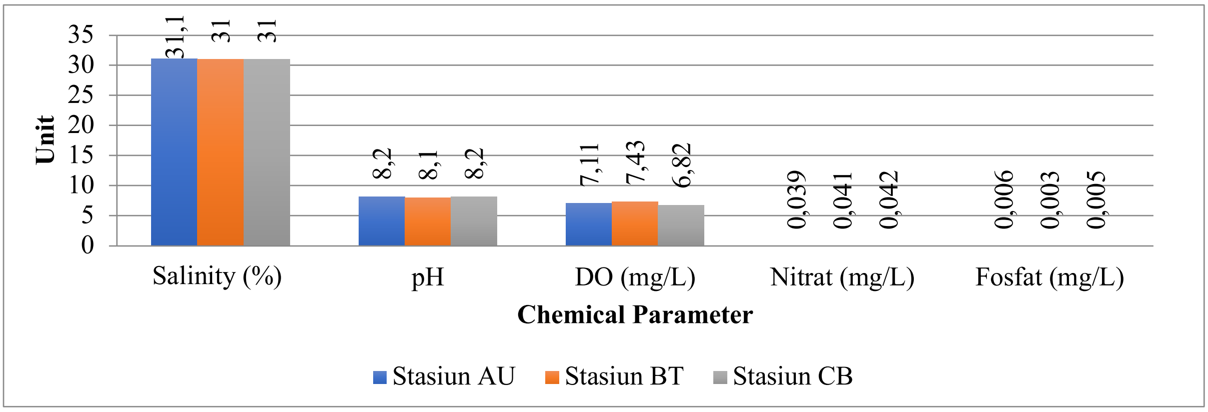

Figure 3. Results of Water Chemical Parameter Measurement Based on Station

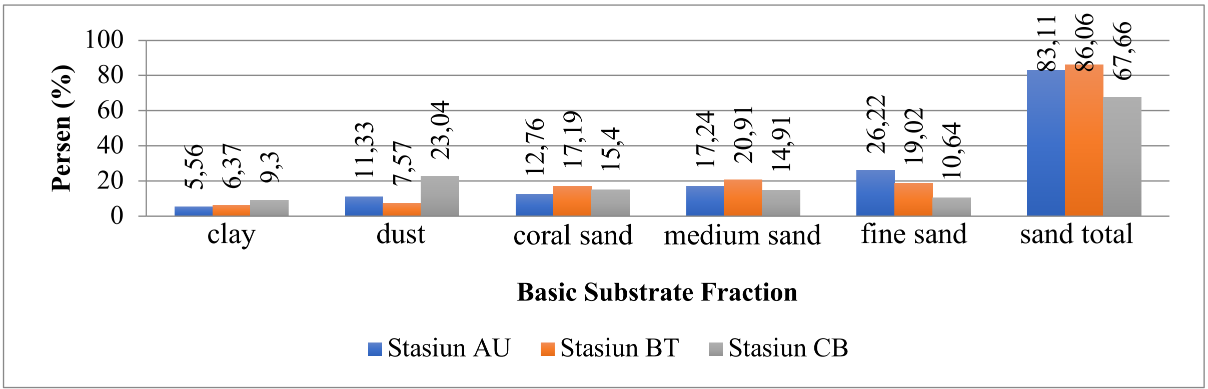

Figure 4. Results of Measurement of Basic Water Substrate Parameters by Station

Distribution of Physico-Chemical Characteristics of Water and Basic Substrates by Station

The distribution of physico-chemical characteristics and basic water substrates by station is shown in Figure 5. Based on Figure 5, it shows that the data analysis contributes information to Factor 1 (F1) of a total of 54.84% and Factor 2 (F2) of 45.16% with total information is 100%. Station AU is characterized by high temperature, salinity, pH, phosphate, Station BT is characterized by high turbidity, nitrate and coarse sand, Station CB is characterized by high current velocity, clay and dust fractions (Figure 5).

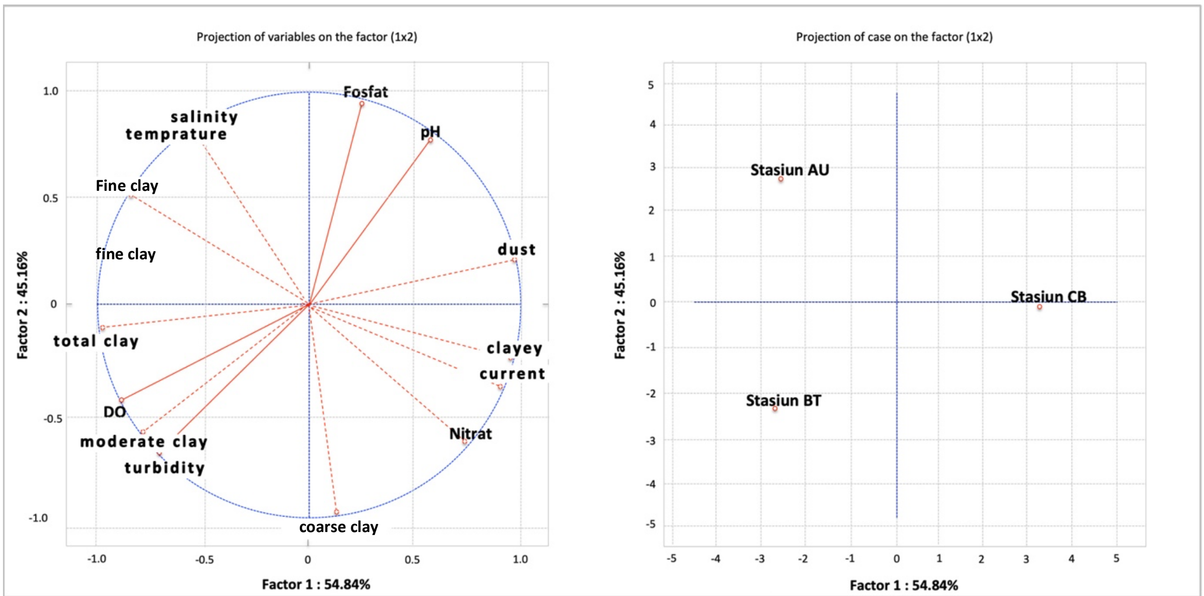

Figure 5. Distribution of Physico-Chemical Parameters and Basic Substrates Based on Station

Density and Coverage of *E. acoroides*

Badak Badak Island seagrass are only composed of *E. acoroides* with a density range of 137-175 stands/m^2 with an average of 156 stands/m^2. Stands of *E. acoroides* by station are shown in Figure 6.

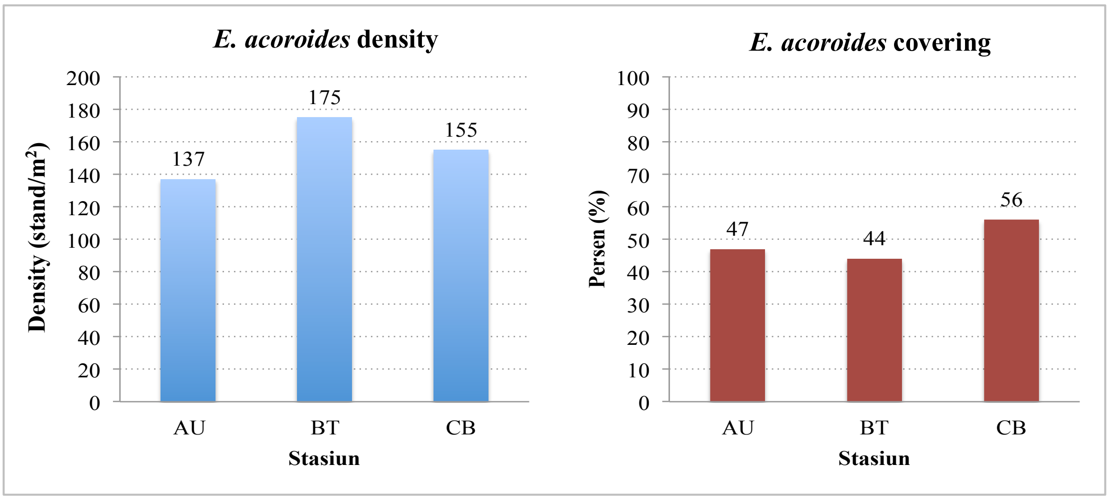

Figure 6. Density and Coverage of *E. acoroides* Based on Station

Nutrient Content in Leaves and Rhizomes *E. acoroides*

The nutritional content of the leaves and rhizomes of *E. acoroides* from the proximate test results is listed in Table 2 and Table 3.

Table 2. Leaf Proximate Test Results

No.	Parameter	Stasiun (%)			Average
		AU	BT	CB	
1.	Moisture content	36,69	38,28	36,3	37,09
2.	Ash content	18,37	19,02	18,36	18,58
3.	Lipid	0,87	0,93	0,59	0,80
4.	Protein	2,43	2,51	2,13	2,36
5.	Carbohidrate	41,17	40,12	41,29	40,86

Tabel 3. Rizoma Proximate Test Results

No.	Parameter	Stasiun (%)			Average
		AU	BT	CB	
1.	Moisture content	22,95	23,42	25,55	23.97
2.	Ash content	13,23	12,97	14,62	13.61
3.	Lipid	0,80	0,72	0,42	0,65
4.	Protein	2,02	2,05	1,75	1,94
5.	Carbohidrate	48,04	48,18	46,61	47,61

DISCUSSION

Habitat Characteristics *E. acoroides*

Basic Physico-Chemical Parameters of Water and Substrate

Suhu perairan di padang lamun P. Badak Badak rata-rata 30,2°C (Gambar 2), rata-rata suhu tersebut masih dalam kisaran baku mutu untuk padang lamun yaitu 28-30°C. Kekeruhan perairan berkisar 6,97-7,52 NTU (Gambar 2) dengan rata-rata 7,17 NTU. Kekeruhan tertinggi di Stasiun BT dan kekeruhan terendah di Stasiun CB, berdasarkan kisaran dan rata-rata tersebut cenderung telah melampaui baku mutu untuk biota laut yaitu 5 NTU. Kecepatan arus berkisar 0,23-0,56 m/detik dengan rata-rata 0,37 m/detik. Kecepatan arus tertinggi di Stasiun CB dan terendah di Stasiun AU, hal ini menunjukkan bahwa *E. acoroides* mampu beradaptasi dengan kisaran kecepatan arus tersebut. Salinitas berkisar 31-31,1‰ dengan rata-rata 31‰ (Gambar 3), kisaran dan rata-rata salinitas tersebut di bawah baku mutu salintas untuk padang lamun yaitu 33-34‰. Adanya kecenderungan tingginya kekeruhan dan kecepatan arus serta lebih rendahnya salinitas daripada baku mutu terutama di Stasiun CB disebabkan adanya masukkan massa air tawar dari Sungai Tanjung Limau.

Kisaran pH yaitu 8,1-8,2 dengan rata-rata 8,2 (Gambar 3), kisaran dan rata-rata pH tersebut masih dalam kisaran baku mutu yaitu 7-8,5. Kandungan DO berkisar antara 6,82-7,43 mg/l dengan rata-rata 7,12mg/l. Kisaran dan rata-rata DO tersebut lebih besar dari nilai baku mutu yaitu 5 mg/l dengan kandungan DO tertinggi di Stasiun BT dan terendah di Stasiun CB. Adanya kecenderungan tingginya kandungan DO disebabkan oleh proses fotosintesis di daun dan berkaitan pula dengan kerapatan tegakan *E. acoroides* dimasing-masing stasiun berkisar 104-184 tegakan/m^2 dengan kerapatan tertinggi di Stasiun BT.

Kandungan nitrat berkisar 0,039-0,042 mg/l (Gambar 3) dengan rata-rata 0,041mg/l, kisaran dan rata-rata nitrat tersebut cenderung lebih rendah dari nilai baku mutu yang dipersyaratkan yaitu 0,06 mg/l dengan kandungan nitrat tertinggi di Stasiun CB. Kandungan fosfat berkisar 0,003-0,006 mg/l dengan rata-rata 0,005 mg/l, kisaran dan rata-rata fosfat tersebut cenderung lebih rendah dari baku mutu yang dipersyaratkan yaitu 0,015 mg/l dengan kandungan fosfat tertinggi di Stasiun AU dan terendah di Stasiun BT.

Fraksi liat berkisar 5,56-9,30% (Gambar 4) dengan rata-rata 7,08% dengan kandungan fraksi liat tertinggi di Stasiun CB dan terendah di Stasiun AU. Fraksi debu berkisar 7,57-23,04% (Gambar 4) dengan rata-rata 14,0% dengan kandungan fraksi debu tertinggi di Stasiun CB dan terendah di Stasiun BT. Fraksi pasir kasar berkisar 12,76-17,19% (Gambar 4) dengan rata-rata 15,4% dengan kandungan fraksi pasir kasar tertinggi di Stasiun BT dan terendah di Stasun AU. Fraksi pasir sedang berkisar 14,91-20,91% (Gambar 4) dengan rata-rata 17,7% dengan kandungan fraksi pasir sedang tertinggi di Stasiun BT dan terendah di Stasiun CB. Fraksi pasir halus berkisar 10,64-26,22% dengan rata-rata 18,6% dengan kandungan fraksi pasir halus tertinggi di Stasiun AU dan terendah di Stasiun CB. Kisaran total pasir berkisar 67,66-86,06% (Gambar 4) dengan rata-rata 78,9% dengan total pasir tertinggi di Stasiun BT dan terendah di Stasiun CB. Pengelompokan berdasarkan tekstur substrat maka Stasiun AU dan BT bertekstur pasir berlempung dan Stasiun CB bertekstur lempung berpasir.

The water temperature in the Badak Badak Island seagrass beds averages 30.2ºC (Figure 2), the average temperature is still within the quality standard range for seagrass beds, namely 28-30ºC. Water turbidity ranges from 6.97 to 7.52 NTU (Figure 2) with an average of 7.17 NTU. The highest turbidity is at BT Station and the lowest turbidity is at CB Station, based on the range and average, it tends to exceed the quality standard for marine biota, namely 5 NTU. The current speed ranges from 0.23 to 0.56 m/sec with an average of 0.37 m/sec. The highest current speed was at Station CB and the lowest at Station AU, this shows that *E. acoroides* is able to adapt to this range of current speeds. Salinity ranges from 31-31.1‰ with an average of 31‰ (Figure 3), the range and average salinity is below the salinity quality standard for seagrass meadows, namely 33-34‰. There is a tendency for high turbidity and current speed as well as lower salinity than the quality standard, especially at CB Station due to the influx of fresh water masses from the Tanjung Limau River.

The pH range is 8.1-8.2 with an average of 8.2 (Figure 3), the range and average pH is still within the quality standard range, namely 7-8.5. The DO content ranged between 6.82-7.43 mg/l with an average of 7.12 mg/l. The range and average DO is greater than the quality standard value, namely 5 mg/l with the highest DO content at Station BT and the lowest at Station CB. There is a tendency for high DO content to be caused by the photosynthesis process in the leaves and is also related to the stand density of *E. acoroides* at each station ranging from 104-184 stands/m^2 with the highest density at Station BT.

The nitrate content ranges from 0.039-0.042 mg/l (Figure 3) with an average of 0.041mg/l, the range and average of nitrate tends to be lower than the required quality standard value, namely 0.06 mg/l with the highest nitrate content in CB Station. The phosphate content ranges from 0.003-0.006 mg/l with an average of 0.005 mg/l, the range and average of phosphate tends to be lower than the required quality standard, namely 0.015 mg/l with the highest phosphate content at AU Station and the lowest at BT Station.

The clay fraction ranges from 5.56-9.30% (Figure 4) with an average of 7.08% with the highest clay fraction content at CB Station and the lowest at AU Station. The dust fraction ranges from 7.57 to 23.04% (Figure 4) with an average of 14.0% with the highest dust fraction content at CB Station and the lowest at BT Station. The coarse sand fraction ranges from 12.76-17.19% (Figure 4) with an average of 15.4% with the highest coarse sand fraction content at BT Station and the lowest at AU Station. The medium sand fraction ranges from 14.91-20.91% (Figure 4) with an average of 17.7% with the highest medium sand fraction content at Station BT and the lowest at Station CB. The fine sand fraction ranges from 10.64-26.22% with an average of 18.6% with the highest fine sand fraction content at AU Station and the lowest at CB Station. The total sand range is 67.66-86.06% (Figure 4) with an average of 78.9% with the highest total sand at Station BT and the lowest at Station CB. Grouping based on substrate texture, Stations AU and BT have a clayey sand texture and CB Station has a sandy clay texture.

Density and Coverage of *E. acoroides*

The average density of E. acoroides ranges from 137-175 stands/m^2 (Figure 1) with an average of 156 stands/m^2, the highest stand density at Station BT and the lowest at Station AU with a clayey sand base substrate type (Figure 4). The trend in the range and average density of *E. acoroides* at Station BT is closely related to the characteristics of its habitat which is characterized by high turbidity, nitrate and coarse sand (Figure 5). Based on the range and density, it shows in the criteria of dense (density 125-175 stands/m^2) to very dense (density >175 stands/m^2) (Gosari & Haris, 2012). The density of *E. acoroides* in Badak Badak Island tends to be higher than the density of E. acoroides in the multi-species seagrass meadows of Madong Bay which reaches 30 stands/m^2 with a mud substrate type (Sari *et al.,* 2020) and Rina *et al.*, (2019) reported that the microhabitat of *E. acoroides* is sandy mud.

The average cover of E. acoroides ranged from 44-56% (Figure 1) with an average of 48.33%, the highest cover at CB Station and the lowest at AU Station. The range and average cover of E. acoroides is related to the status of seagrass meadows (Minister of Environment Decree No. 200/2004) in damaged status and less rich/healthy conditions (cover: 30-59.9%). The tendency for a higher percentage of cover at CB Station than at other stations is closely related to the characteristics of the habitat which is characterized by high current speed, clay and dust fractions (Figure 5) and sandy clay substrate type, even though the nitrate and phosphate content is lower than the stated quality standards (Figure 3). These conditions tend to be better than the percentage cover of E. acoroides ranging from 10-40%, the lower percentage cover is related to the type of substrate, sand mud, sand and sand-coral (Rustam et al., 2015). Nabila et al. (2019) reported that nitrate and phosphate content above the quality standard was positively correlated with the high cover of *E. acoroides* in the seagrass beds of Awur Bay, Jepara, which reached 82%.

Nutrient Content in Leaves and Rhizomes of E. acoroides

The ash content in E. acoroides leaves ranges from 18.36-19.02% with an average of 18.56% (Table 3), as do the test results from Huriawati et al. (2016) ranged from 18.83-19.39% and Tuapattinaya et al. (2021) namely 18.25-18.56% with an average of 18.53%. This shows that the ash content of E. acoroides leaves, even in different places, has relatively the same ash content or has relatively the same biomass and organic carbon potential. Meanwhile, the ash content in the rhizomes ranged from 12.97-14.62% with an average of 13.61% (Table 4) and this average was relatively smaller than the ash content in the leaves with a ratio of 1:1.36. If the ash content in leaves and rhizomes is grouped based on the ash content on the substrate, the average ash content reaches 32.17%, this average is relatively lower than the ash content of E. acoroides on the substrate in Karang Sewu, Gilimanuk, Bali which reaches 37 % (Lestari et al., 2020). The potential high ash content of E. acoroides in the upper part of the substrate can be compared with the results of the average ash content of the Thalassia hemprichii, Cymodocea rotundata and E. acoroides composite on Nusa Lembongan Beach, Klungkung, Bali, namely 24.48% (Negara et al., 2020), this shows that the average ash content of E. acoroides is higher than the ash content of other seagrass species.

The fat content in the leaves ranges from 0.59-0.93% with an average of 0.80% (Table 3) and the fat content in the rhizomes ranges from 0.42-0.80% with an average of 0.65% (Table 4) with a ratio of fat content in the rhizomes and leaves, namely 1:1.23 or the fat content in the leaves is higher than in the rhizomes. The fat content in leaves and rhizomes or grouped into fat content on the substrate ranges from 0.65-0.80% with an average of 0.73%, so this range and average tends to be higher than the fat content of litter E. acoroides at Tawang Pacitan Beach, namely 0.54-0.74% with an average of 0.64% (Huriawati et al., 2016) as well as the fat content in E. acoroides fruit reaching 0.66% (Minsas et al., 2023) and Ratnawati et al. (2019) reported that the fat content in the seeds and seed pods of E. acoroides was 0.76% and 0.69%, respectively. This shows that the fat content in E. acoroides leaves tends to be higher than other parts.

The protein content in the leaves ranges from 2.13-2.51% with an average of 2.36% (Table 3) and the protein content in the rhizomes ranges from 1.75-2.05% with an average of 1.94% (Table 4) with a ratio of protein content in the rhizomes and in the leaves, namely 1:1.23 or the protein content is higher in the leaves than in the rhizomes. Kaya (2017) reported that the protein content in E. acoroides rhizomes reached 0.75%. The protein content in the leaves and rhizomes or grouped into protein content on the substrate ranges from 1.94-2.36% with an average of 2.15%, this range and average is lower than the protein content in seeds and seed pods of E . acoroides namely 9.61% and 9.47% (Ratnawati et al., 2019) as well as the report by Kole et al. (2020) the protein content in seeds reaches 8.10%.

The carbohydrate content in the leaves ranges from 40.12-41.29% with an average of 40.86% (Table 3) and the carbohydrate content in the rhizomes ranges from 46.61-48.18% with an average of 47.61% (Table 4) with a ratio of carbohydrate content in the leaves and in the rhizomes, namely 1:1.17 or the carbohydrate content is higher in the rhizomes than in the leaves. The carbohydrate content in the leaves and rhizomes or grouped into carbohydrate content on the substrate ranges from 40.86-47.61% with an average of 44.24%. This range and average is lower than the carbohydrate content in E. acoroides seeds, namely 80.48% and higher than the carbohydrate content in seed pods of 42.77% (Ratnawati et al., 2019), if the carbohydrate content in seeds and pods If the seeds are composited, the carbohydrate content reaches 61.63%. This shows that the carbohydrate content is higher in seeds and seed pods than in other parts of E. acoroides and also shows that seeds and seed pods are a potential alternative source of carbohydrates (Wakano, 2013).

CONCLUSSION

The conclusion of this research are list bellow :

1. The average ash content in the leaves is 18.56% and in the rhizomes 13.61% with a ratio in the rhizomes to the leaves of 1:1.36.

2. The average fat content in the leaves is 0.80% and in the rhizomes 0.65% with a ratio in the rhizomes to the leaves of 1:1.23.
3. The protein content in the leaves averages 2.36% and in the rhizomes an average of 1.94% with a ratio in the rhizomes to leaves of 1:1.23.
4. The carbohydrate content in the leaves averages 40.86%, in the rhizomes the average is 47.61% with a ratio in the leaves to the rhizomes of 1:1.17.

ACKNOWLEDGMENTS

Coordinator of the Fisheries Resource Management and Marine Science Study Program, Mulawarman University (FPIK Unmul), East Kalimantan Agricultural Instrument Standards Application Center Laboratory (BPSIP), Water Quality Laboratory FPIK Unmul and Soil Laboratory of the Faculty of Forestry UNMUL who facilitated this research.

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