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Proximate Composition of Shell (Bivalves) in North Aceh District, Aceh Province Based on Differences in Species and Environmental Characteristics

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Abstract

Shellfish (bivalves) are potential biodiversity of waters with an important significant value used by the community as a food source of highly nutritious animal protein. Based on survey results, several coastal areas in North Aceh District have the potential for shellfish. Still, there have not been any scientific reports on this region's proximate composition of bivalves. This study aims to determine the relative arrangement of the dominant bivalves in the North Aceh District based on species differences and environmental characteristics. The results showed varying proximate bivalve proximate compositions of 4 chief types of shellfish in North Aceh waters. Bivalvia water ranged from 6.9-14.2%, ash ranged from 5.87-8.29%, protein ranged from 32.84-35.87%, fat ranged from 3.04-10.83%, and carbohydrate ranged from 38.11-42.71%. The highest protein and fat content were found in the Crassostrea sp1 type clams. In addition, the differences in the environmental characteristics of the shell sampling locations also resulted in different proximate compositions. The PCA test results showed that the critical variablarrangemente composition was ash and fat content. The environmental parameters, which were the key parameters of the relative arrangement of the shells were the substrate and pH.

Keywords: *Bivalves, Environmental Characteristics, North Aceh, Proximate Composition.*

1. Introduction

Bivalvia or shellfish is one of the biodiversity found in Indonesian waters. Huber (2010) reports that the number of marine bivalves (including brackish waters and estuarine bivalves) is estimated at 8000 species belonging to 4 subclasses and 99 families with 1100 genera. [1]. Shellfish (Bivalvia) are marine organisms that can live in all types of waters, namely freshwater, estuarine and marine waters [2].
Shellfish (bivalves) include the potential biological wealth of waters wcrucialtant economic value [3]. Many people like shellfish because it tastes good, is easy, and has high nutritional value [4]. In addition, shell waste can also be used to make lime, decoration, and also a source of calcium. Shellfish have been studied to contain high nutrients such as protein, fat, carbohydrates, vi, tam, and imineralsneralsl [5]. Shellfish are rich in essential and non-essential amino acids [6]. Shellfish can be an alternative source of omega-3, command ga-6, and omega-9 and a source of vitamins A and D and minerals [7].
The nutritional content of shellfish varies significantly because it is influenced by several factors, namely habitat, species, sex, age, diet, temperature, and season [8]. Differences in the location of shellfish and different environmental characteristics from one region to another will undoubtedly affect the shellfish's nutritional content, so the same type o shel will probably have a different nutritional composition. [9]. Thus the nutritional content of shellfish needs to be analyzed foreknown the quality of shellfish in an area [10].
Aceh waters have reported the existence of several species of shellfish that the community, such as Lokan clams in West Aceh, blood clams in Ulee Lheue Banda Aceh waters, green mussels and oyster shells on the coast of Kuala Langsa and freshwater clams in Aceh Jaya have consumed [11]. However, until now, there has yet to be a scientific report on the proximate composition of bivalves (bivalves) in North ADistrictt ThusThuss this study aims to determine the relative arrangement of bivalves in North Aceh waters based on species differences and differences in environmental characteristics [12].

2. Methods

This research is an experimental laboratory study, namely analyzing the proximate content of bivalve meat or shellfish based on different types of shellfish and differences in environmental characteristics of shellfish sampling. The relative content tested included moisture content test, ash content test, fat content test, protein content test, and carbohydrate content test with three repetitions each.

2.1 Determination of Research Stations

In the early stages, a survey was carried out to determine the research location for the presence of bivalves on the coast of North Aceh Regency to determine station points. The research station points were carried out in seven sub-districts in the North Aceh region, as presented in Figure 1.

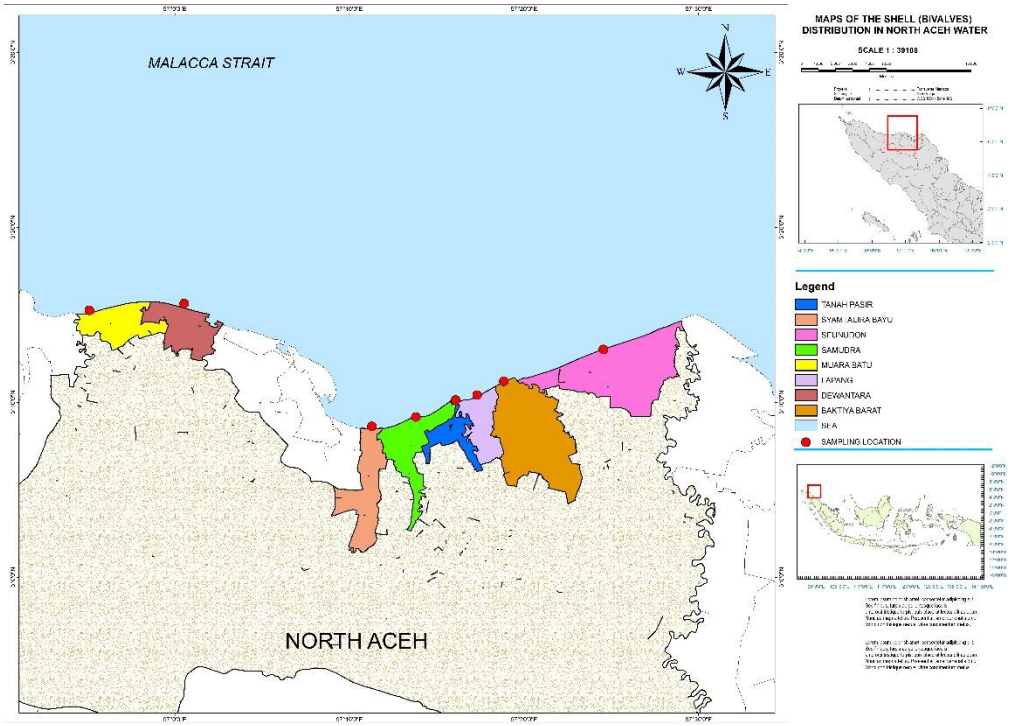


Fig 1. Map of Research Locations

2.2 Shell Sample Preparation

Shellfish samples were obtained from seven districts using the purposive sampling method. The shell samples analyzed were those with relatively high densities based on research by Erniati et al. (2022). The mussel samples were taken from the flesh, cleaned, and dr,ied in the oven at 60^0 C for 24 hours. After drying, the clam meat samples were mashed with a blender. This refined shellfish meat sample will be used for proximate analysis.

2.3 Proximate Analysis

The proximate composition analyzed consisted of moisture, ash, protein, fat, crude fiber, and carbohydrate content. Analysis of moisture content using the oven method, analysis of ash content using the Furnaceance method, analysis of protein content using the Kjeldahl method, breakdowns of fat using the sox levitation method, analysis of crude fiber using the gravimetric method, and analysis of carbohydrates using the by differenwayod [13].

2.4 Data analysis

Proximate data of clam meat based on species differences and differences in environmental characteristics obtained are presented in tabular form and analyzed descriptively. A multivariate analysis approach wasrelativeout based on principal component analysis (Principal Component Analysis or PCA) to see the relationship between the relative levels of shellfish and environmental characteristics. This analysis is a descriptive statistical method to present the complete information in a data matrix in graphical form. The data matrix consists of research locations as individual statistics (row matrix data) and data on environmental characteristics as statistical variables (column matrix data).

3. Results and Discussion

3.1 Proximate Composition of Shells based on species differences

The proximate composition of clams in North Aceh based on species differences is presented in Table 1.

Table 1. Proximate composition of clams in North Aceh based on species differences

Number	Types of Shells	Proximate Characteristics (%)				
		Water content	Ash Content	Fat level	Protein Content	Carbohydrate Content
1	*Anadara granosa*	14,20 ± 0,24	5,87 ± 0,20	3,04 ± 0,01	34,16 ± 0,04	42.71 ± 0,40
2	*Crassostrea sp1*	6,90 ± 0,08	8,26 ± 0,43	10,83 ± 0,01	35,87 ± 0,24	38,11 ± 0,76
3	*Meretrix sp*	8,42 ± 0,38	8,29 ± 0,17	3,54 ± 0,74	32,84 ± 0,41	46,88 ± 1,71
4	*Donax cuneatus*	9,42 ± 0,38	7,29 ± 0,17	4,54 ± 0,74	33,84 ± 0,41	43,88 ± 0,65

Source: Research data

Table 1 shows species differences resulting in other shellfish's different proximate composition (moisture, ash, fat, protein, crude fiber, and carbohydrate content). Gafari (2011) states that variations in the design of the proximate nutritional content in shellfish can occur between species and individuals within one species. The highest water content in this study was found in the Anadara granosa species, and the lowest water content was in the Crassostrea sp1 species. The varying water content between shellfish species is due to the morphological differences between the shellfish species. There are thick morphological shells and thin flesh structures. Before the drying process, the initial moisture content between the clam species differs. Thus, the drying process given at the same time and temperature will produce different final moisture content of the shell meat. Biandolino et al. (2020) stated that the moisture content of mussel meat was greatly influenced by the physical condition of the mussel meat structure, which differed between species. Vineetha et al. (2020) suggested that physiological conditions, the reproductive cycle, and the physical condition of the mussel, grreproductiveence the moisture content of mussel meat. Water is essential in food ingredients because water can affect appearance, texture, and taste. Even dry food contains a certain amount of water [14]. The moisture content of foodstuffs affects physical and chemical aspects and is considered an indicator of the freshness and good quality of seafood such as shellfish [15].

The results of the analysis of ash content produced values that varied between shellfish species. Ash content describes the mineral content of a material being analyzed. This is to the statement of Nurwin et al. (2019) that ash content is the residue of inorgannumbermineral components found in a food ingredient. The ash content of a food ingredient describes the number of minerals burned into non-volatile substances. Based on Table 1, the ash grams of the Crassostrea sp1 and Mere-Trix sp species have relatively the same vgramshile the Anadara grams species has a lower ash content (5.87%)[16]. The ash content of Anadara grams from the waters of North Aceh Regency was relatively higher than the water content from TomigramsBoalemo Gorontalo, namely 2.4% (Nurjannah et al. 2005) and lower than the ash content of Anadara grams from Malaysian waters (9.8-17.5%) (Min et al. 2011) [17]. The ash content varies between species because each shellfish species differs in its ability to store tiny bodies in its surroundings. In general, the ash content in large shells is relatively higher than in small shells; more giant shells have a higher ability to store or blog. Clams have a habit of eating as a filter feeder and deposit feeder, so through this eating habit, the shells will absorb and store minerals [18].

Fat is a more useful energy source for organisms than carbohydrates and protein. Nurjana et al. (2015) stated that the fat contained in aquatic products contains E, PA, and DHA fatty acids, which are very good for health. In the study's results, Abdullah et al. (2013) stated that shellfish contain omega-3, which is very good for health. The fat content of the four shellfish species analyzed had varying values. Species Meretrix sp, Ana-Dara granola, and Donax cuneatus have relatively the same value, and the species with the highest fat content value is Crassostrea sp1. The lipid content of Crassostrea sp1 from North Aceh waters was higher than that of Crassostrea from Rushan Bay waters, Shandong province, China, namely 3.98-5.1 5%. Meanwhile, the fat content of Donax cuneatus from North Aceh waters was also higher than the fatthatax cuneatus from South Indian waters, namely 1.2% (Idayachandiran et al. 2014). The fat content of Anadara granosa in this study was lower than that of Anadara granosa from Banggai Regency, South Sulawesi, namely 8.47%. Differences in fatDifferent physiological and morphological conditions between clam species cause differences in fat content between bivalve species2003) it stated that the ft content of clam meat was influenced by external factors, namely environmental conditions and food availability, as well as internal factors,s such as metabolic and physiological l activity of shellfish which differed between,n species. The fat content is also affected by the size of the clam meat, where the large size of the heart, the fat content is also high. In addition, the fat content is also affected by the water content of each species, where a highwater content will cause a low-fat range. Table 1 shows that the fat content of Anadara granosa is the lowest due to the highwater content in the clam meat of this species.

Protein is one of the primary nutrients found in shellfish. Supriyantini et al. (2012) reported that clam meat is a complete protein because the animal protein source contains essential amino acids ranging from 85-95%. The results showed that the meat of the four dominant clam species in North Aceh had a relatively high protein content of 32.84%-35.87¬%. Crassostrea sp1 clams had the highest protein value of 35.87% compared to other species. The four clam species in North Aceh waters had a higher protein content than the bivalve species (snow clam) from Muara Angke Jakarta (11.37%). Still, the protein content was lower than that of the Anadara granosa clam from Tomini Bay, Gorontalo. (76%) (Nurjanah et.al., 2005). The protein content in clam meat depends on the species, nutritional condition, ons, and the type of mussel muscle (Yildirim & Ercan, 2016). The eating habits of shellfish are also suspected of causing differences in protein content and the water-holding capacity of different shellfish affecting protein content [19].

The results of calculations by difference show that the levels of carbohydrates found in the four species of mussel meat on the coast of North Aceh have relatively the same value. The Meretrix sp clam species had a higher carbohydrate content (46.88%) than other shellfish species in this study. The carbohydrate content in clam meat is mainly from glycogen, and carbohydrate changes may be due to the accumulation and utilization of glycogen at different stages, such as gametogenesis and spawning. The carbohydrate content values of the four clam species analyzed were higher (38.11%-46.88%) than the snow clam meat from Muara Angke Jakarta (33.55%). However, the protein content of the shellfish analyzed had a lower value than the Semele sp clam (67.678%) from Bonea Village, South Sulawesi. [20].

3.2 Proximate Composition of Shells based on Differences in Environmental Characteristics

The proximate composition of a food ingredient is influenced by the characteristics of the environment in which the biota resides. Theuerkauf et al. (2022) stated that the survival of an organism is strongly supported by an aquatic environment that can provide nutrients. To see the effect of differences in environmental characteristics on the proximate composition of clams, a comparative analysis was performed on the meat of Anadara granosa clam species obtained from five sub-districts in North Aceh with different environmental characteristics of sampling locations. The results of the analysis of the proximate composition of Anadara granosa clam meat from five sub-districts in North Aceh are presented in Table 2. Meanwhile, the environmental characteristics of the five mussel sampling locations are shown in Table 3.

Table 2. The proximate composition of Anadara granosa in five sub-districts in North Aceh

Research sites	Proximate Composition (%)				
	Water content	Ash Content	Fat level	Protein Content	Carbohydrate Content
Muara Batu	14,2 ± 0,24	5,87 ± 0,20	3,04 ± 0,01	34,16 ± 0,04	42,71 ± 0,40
Syamtalira Bayu	19,61 ± 0,11	4,75 ± 0,06	3,46 ± 0,08	33,57 ± 0,04	38,59 ± 0,04
Seuneuddon	9,41 ± 0,23	6,69 ± 0,49	3,68 ± 0,38	30,72 ± 0,67	49,47 ± 1,02
Tanah Pasir	10,85 ± 0,12	4,73 ± 0,17	6,71 ± 0,43	34,24 ± 0,51	43,44 ± 0,21
Samudra	8,41 ± 0,17	8,74 ± 0,21	8,42 ± 0, 68	34,46 ± 0,47	44,31 ± 0,78

Table 3. Environmental characteristics of the shell sampling locations in five sub-districts in North Aceh

Research sites	Environmental Characteristics				
	pH	Salinity (ppt)	Temperature (°C)	DO (mg/L)	Substrate Characteristics
Muara Batu	6.9	30	30.3	6.3	Sandy mud
Syamtalira Bayu	7.1	30	30.2	6.3	Sandy beach with strong waves
Seuneuddon	6.9	29	29.8	6.3	Stone and muddy
Tanah Pasir	7	29	29.3	6.2	Sand with calm waves
Samudra	7.1	30	30.2	6.1	Mud

Table 2 shows that the proximate nutritional content of Anadara granosa clams obtained from five sub-districts in the North Aceh district showed varying values. This is due to differences in the characteristics of the research location's geographical environment, which will produce different proximate levels. One environmental characteristic affecting mussels' relative levels is the substrate in the aquatic environment. In this study, the five research locations where Anadara granosa samples were taken had different substrates; Muara Batu District had a sandy mud substrate. In contrast, Syamtalira Bayu District had a sandy beach substrate with heavy waves, Tanah Pasir District had a sandy substrate with calm waves, and Seuneddoen Subdistrict had a rock Samudera Subdistrict had a muddy substrate. Anggo (2017) states that differences in shellfish environmental conditions can cause different proximate levels. Dewi et al. (2018) noted that the bottom substrate of the waters is essential for the survival of clams, namely for finding food, spawning, or reproducing.

Based on the proximate content, Anadara granosa clams from Samudra District had ash, fat, and protein content, which were higher than other sub-districts. This is closely related to the condition of the substrate in the waters in the Samudra District where the samples were taken, which has a muddy substrate. Nybakken (1988) states that sediment substrates with smaller granules, such as silt, are better able to store nutrients than larger sediment substrates, such as sand or gravel. Imamsyah et al. (2020) also stated that sediment substrates with finer particles will have higher organic matter nutrients. Because the Subdistrict of Samudra, the condition of the substrate is muddy, it will have more nutrients available so that Anadara granosa clams from this Subdistrict will absorb higher nutrients. Thus, the proximate ash, fat, and protein content is also higher than Anadara granosa in other subdistricts.

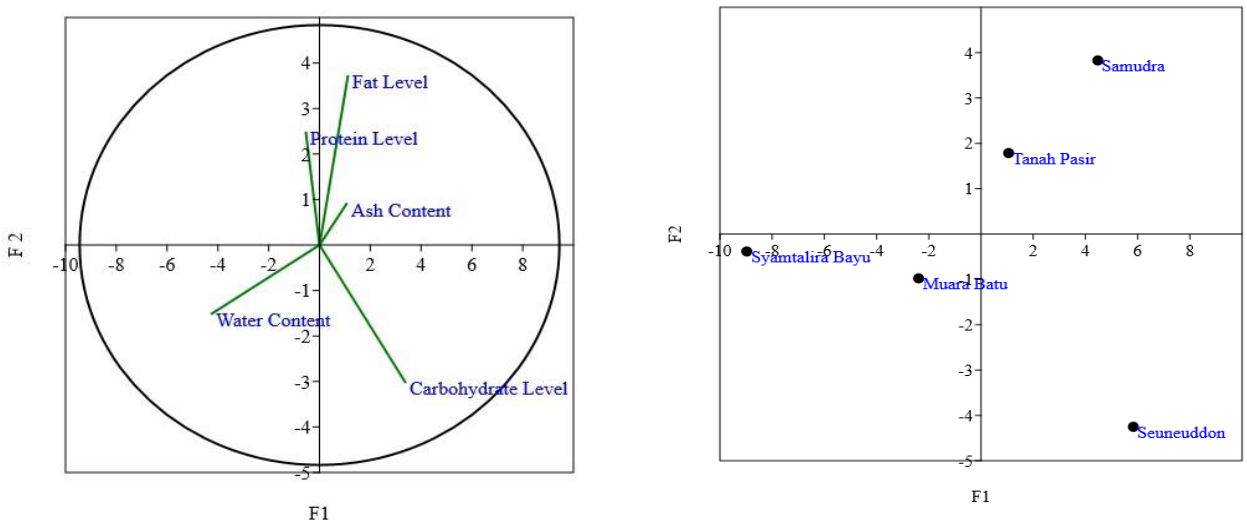
Other environmental characteristics that were measured were water quality parameters, namely temperature (29.3-30.3oC), pH (6.9-7.1), DO (6.1-6.3 mg/L) and salinity (29-30 ppt) which had relatively the same values in the five sub-districts and is a condition that is still suitable for the growth of clams. This is to the statement of Suryono et al. (2017) that water quality parameters that still support the life of mussels are temperature ranging from 29.4-31oC, pH ranging from 6.83-7.75, DO ranging from 5.51-6.9 mg/L and salinity having a value of 29 -30 ppt. Temperature, pH, DO, and salinity is water quality parameters affecting mussel metabolism. Efendi (2003) states that the temperature of the aquatic environment will affect the speed of metabolism and respiration of marine organisms. Odum (1993) said that dissolved oxygen content is significant for macrozoobenthos such as bivalves, especially in the process of respiration and decomposition of organic matter, which will affect the nutritional content of these organisms. A biota that has good metabolic and respiratory activity will be able to absorb nutrients properly. Urrutia et al. (2001) suggested that the water's temperature, salinity, and pH will affect the clams' life and the proximate composition.

3.3 The Relationship between Environmental Characteristics and Proximate Levels of Shellfish

The principal component analysis (PCA) results describe the distribution and correlation between environmental characteristics centered on the two main axes, F1 and F2. PCA test results showed that the proximate compositions which became the key variables were ash content and fat content. Some research locations have unique characteristics for each relative variable, such as Samudera and Tanah Pasir sub-districts, characterized by fat and ash content; Seuneuddon District, represented by carbohydrate content; and Syamtalira Bayu and Muara Batu Districts are characterized by water content (Figure 3).

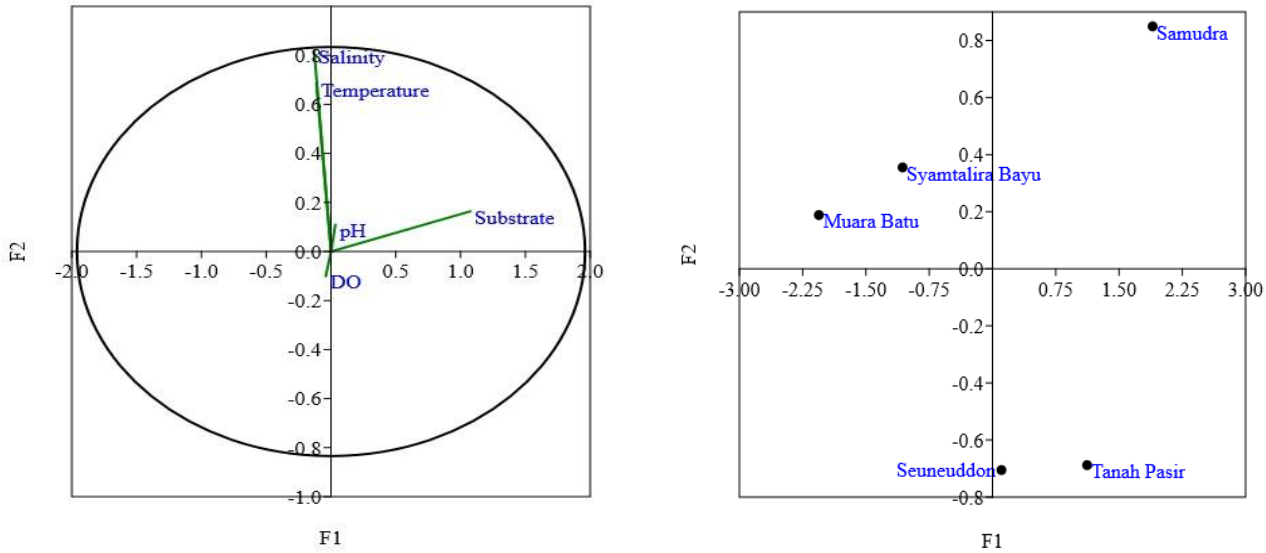
The results of PCA analysis to see the environmental characteristics that characterize relative levels (Figure 4) show that substrate and pH are the critical parameters for focriticalroximate composition. In grouping, several locations have their environmental characteristics, such as Samudra District, which has rocky and muddy substrate characteristics which are not found at other stations and have a relatively low

pH value. The exact temperature and salinity characterize Syamtalira Bayu District and Muara Batu District. Seuneuddon District and Tanah Pasir District do not have any unique characteristics.
Temperature, salinity and pH of a water will affect the life of bivalves so that it will affect the proximate composition. states that differences in substrate conditions and water quality in the environment where shellfish are located will produce different nutrient content.



(a) (b)

Fig 3. PCA analysis diagram. a). Ordination of comparable levels on the F1 and F2 axes. b). Representation of station distribution based on relative levels on the F1 and F2 axes.



(a) (b)

Fig 4. PCA analysis diagram. a). Ordination of water quality parameters on the F1 and F2 axes.
b). Representation of station distribution based on water quality on the F1 and F2 axes.

The relative levels of bivalves (clams) on the coast of North Aceh have varying values based on the different types of shellfish and the different characteristics of the shell sampling environment. The highest water content was found in the clam Anadara granosa (14.20%), the highest ash content in the Meretrix sp (8.30%) type, the highest fat content in the Crassostrea sp1 species (10.84%), the highest protein content in the Crassostrea species sp1 (35.87%), and the highest carbohydrate content was from Meretrix sp (46.88%).
Based on the environmental characteristics of the shell sampling location, the highest proximate content of Anadara granosa from 5 sub-districts on the coast of North Aceh Regency, namely the water content from Syamtalira Bayu District (19.61%), the highest ash content from Samudra District (8.74%), the highest ash content from Samudra District (8.74%), fat from Samudra District (8.42%), protein content

from Tanah Pasir District (35.24%), and the highest carbohydrate content from Seuneuddon District (49.47%). Statistical analysis with the PCA test showed that the proximate compositions which became the key variables were ash content and fat content. The results of PCA analysis to see the environmental characteristics that characterize relative levels indicate that substrate and pH are the key parameters focriticalhe proximate composition of shellfish.

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