ANALYSIS OF BLOOD COCKLE SHELL CONTENT AS A BIOCOMPOSITE MATERIAL ON ULTISOL SOIL

Sari Rahmiati*, Yopy Mardiansyah, Vitri Aprilla Handayani, Moh. Arafat Wasiru
Institut Teknologi Batam, The Vitka City Complex, Tiban, Jl. Gajah Mada, Kota Batam, Kepulauan Riau 29425

Correspondence Author: sari@iteba.ac.id

Submitted	Revised	Published	
27.12.2023	29.04.2024	30.04.2024	© Authors 2024

PISSN 2540-8224
EISSN 2540-8267

Publisher:
Departement of Chemistry FMIPA University of Lampung

ABSTRACT

This research used blood cockle shells (*Anadara granosa*) originating from consumption waste in the Batam City area. Cockle shell samples were taken and prepared for analysis of mineral content using the FTIR method, including $CaCO_3$ and other minerals. The blood cockle shells were applied to ultisol soil in Batam City to improve its fertility. The shells were crushed into a fine powder, then mixed with ultisol soil with several treatments, including 0 grams (control), 10 grams, 20 grams, and 30 grams with a soil mass composition of 220 grams for each treatment. The mixture of soil and shell powder was stirred until homogeneous before being applied to mustard greens plants. Based on the research results, the addition of shell powder had an effect on the level of plant fertility. The experimental results carried out showed an effect on each treatment given. This is in line with statistical testing with analysis of variance, obtaining a sig. value of $0.037 < \alpha = 5\%$ (0.05), indicating a significant difference in treatment for each treatment.

Keywords: Blood cockles, Ultisol Soil.

INTRODUCTION

The blood cockle (*Anadara granosa*) is a type of clam that produces a red-colored liquid containing hemoglobin. Hemoglobin is an oxygen-carrying protein typically found in the red blood cells of vertebrates. The presence of hemoglobin in the blood cockle's fluid indicates an ability to transfer oxygen, although the mechanism may differ from vertebrates. Its body consists of the clam meat and the shell. The part of the blood cockle that is processed as food is the clam meat (Sulistiyaningsih & Arbi, 2020), so that the clam shell itself becomes waste residue from the clam processing process(Noorma Kurnyawaty1), Fitriyana1), Fataa Kusumattaqiin1), Rizky Sulvika Puspa Rinda2), 2020). The waste from blood cockle shells is mostly waste resulting from the consumption of seafood from clams which are highly favored by the people of the Riau Islands.

Until now, there has been no special handling for this shell waste. Leftover shells from consumption are just left to accumulate in garbage areas. If this continues, it will certainly have a negative impact on the environment. If the contents of the cockle shells are examined more deeply based on previous research, it will be found that they contain calcium (Ca)(Pungut & Widyastuti, 2019)(Sinurat et al., 2022). Other research has revealed that blood cockle shells themselves contain many other minerals including $CaCO_3$(Mtavangu et al., 2022),(Mekar & Insani, 2021)(Tasari, 2022) 98.7%, Mg 0.05%, Na 0.9%, P 0.02% and others as much as 0.2%(Amri et al., 2022).

Other research also states that cockle shells contain a fairly high level of CaO (Sudarmawan et al., 2020)(Azzahro, Umei Latifah, 2021)(Akbar et al., 2019). The calcium carbonate found in blood cockle shells has been studied in nanoparticle research (Chemmalar et al., 2021). Based on the relatively high calcium content, blood cockle shells can be used as a filler in a composite material. A composite is a material that consists of two or more combined materials that contribute their respective physical and mechanical properties to improve the composite material. (Nayan et al., 2022). Blood cockle shells have also been used as an organic fertilizer for mustard greens (Fazrina & Winda Yursilla, 2019). Other research has utilized shell waste containing Ca for corn plant growth (Juliutomo et al., 2018). Another study used cockle shell powder to improve soil chemical properties (Setiawan et al., 2021).

The Riau Islands is one of the provinces in Indonesia that has many islands. Thus, the livelihoods of the people generally depend on life at sea. However, there is one settlement in the Barelang area of Batam City that is largely utilized for farming, especially vegetables and fruits. The soil conditions in Batam City are classified as ultisol soil, characterized by a red to reddish-yellow color. Low fertility and high acidity (pH less than 5) are characteristics of ultisol soil, which is less productive (Siregar & Nugroho, 2021). This soil has great potential given its considerable extent.

The dominant soil type in Batam City, Riau Islands, is ultisol soil. Ultisol soil is a type of soil that has undergone advanced weathering and intensive leaching of bases. This soil has characteristics of low fertility, acidic soil pH, and low mineral and organic matter content. Some other factors regarding the characteristics of ultisol soil in Batam City and their influence on agricultural potential include poor soil drainage, which can cause water stagnation and an anaerobic environment, hindering plant growth. The soil drainage conditions in Batam City need to be considered, especially in areas with flat or basin topography. Soil texture dominated by clay or sand fractions can affect the soil's ability to retain water and nutrients. The ultisol soil in Batam City has varying textures, which need to be considered in soil management for agriculture. Climatic factors such as rainfall, temperature, and humidity can affect the rate of soil weathering and the availability of water for plants. The climatic conditions in Batam City, located in an island region, need to be considered in assessing the agricultural potential in that area(Gani et al., 2021).

The characteristics of Ultisol can be improved by adding organic matter or fertilizing, allowing the soil to be utilized for plant cultivation or agricultural activities. According to research findings, adding organic matter in the form of goat and chicken manure that has been incubated for 30 days can alter the physical and chemical properties of the soil, increasing its organic C content, nitrogen, P_2O_5, K, Mg, and Mn content, and decreasing its Fe content. The soil can also become more friable and have a higher moisture content (Siregar & Nugroho, 2021). Other research has used zeolite and compost on ultisol soil. (Balqies et al., 2018).

METHOD

Tools and Materials

The tools used in this research were a mortar and pestle grinder used to grind the shells into powder, an oven used to dry the samples, plastic pots as a planting medium, a scale for weighing the powder and ultisol soil, a ruler for measuring plant height, and FTIR for analyzing the content of blood cockle shell samples. The materials used were blood cockle shell powder samples, ultisol soil, and mustard green seedlings.

The research was conducted from June to August 2023 using a quantitative method with an experimental design. The research design was carried out with 4 treatments and 4 repetitions. The sample used was the blood cockle from the Arcidae family which was analyzed at the Chemical Laboratory of the Batam Institute of Technology for the compound content in the blood cockle shells.

The stages of the process for making organic fertilizer from blood cockle shell raw materials are as follows: (1) the collected samples are cleaned and separated from the meat and shells, (2) the shells are sun-dried and burned to remove the moisture content, (3) the burned shells are finely ground using a mortar and pestle until becoming a shell powder, (4) then the blood cockle shell powder is mixed with the ultisol soil to be tested with 4 variations of shell content mixed, namely 0, 10 grams, 20 grams, and 30 grams with the same soil mass composition of 220 grams for each treatment, (5) the mixing of shell powder and soil is done manually without the addition of nutrients to the soil.

The research stages in analyzing the content of blood cockle shells in ultisol soil are as follows:

1. Preparation Phase
   a. Field observations and literature studies
      Field observations were conducted to identify blood cockle shell waste at seafood restaurants in the city of Batan. A literature study was carried out by selecting the research object, namely blood cockle shells (*Anadara granosa*), and the variable to be investigated, the effect of adding blood cockle shells on the fertility of ultisol soil.
   b. Making blood cockle shells (*Anadara granosa*) is done by washing the shells. Then dried by drying in the hot sun. The blood clam shells are then crushed using a mortar and pestle.
   c. The crushed blood cockle shells were prepared and then stored in sample plastic. To determine the functional groups in blood cockle shell samples, Fourier transform infrared spectroscopy (FTIR) was used at the Chemistry Laboratory, Padang State University.
2. Implementation Stage
   Blood cockle shell powder containing calcium was applied to ultisol soil to determine the effect of green vegetable growth in the Barelang area, Batam.
3. Testing Phase
   At the testing stage, an analysis of the growth of green plants (mustard greens) was added to which blood cockle shell powder was added by looking at the growth of green plants (mustard greens) with descriptive analysis. Green plants (mustard greens) can be harvested 40 days after planting and observed every 10 days to see the development of the plants. Observations were made on mustard greens that were given blood cockle shell powder compared to mustard plants that were not given blood cockle shell powder.
4. Final Stage
   At this stage, we conclude the analysis of the content of blood cockle shells as biocomposite material in ultisol soil. By analyzing the effect of applying blood cockle shell powder to ultisol soil. With a comparison between soil with added blood cockle shell powder and without blood cockle shell powder.

RESULTS AND DISCUSSION

The research carried out produced data in qualitative and quantitative form. Quantitative data was obtained from observing plant height and qualitative data was obtained from observing the quality of stems and leaves. This research design was carried out with 4 types of treatment and 4 repetitions. The data in Table 1 shows the height of the plant stems that grew after 4 days after the seeds were planted.

Table 1. Experimental Design

No	Treatment	Stem Height (cm)			
		1	2	3	4
1	0	1,8	1,6	2,5	0
2	10 gram	2, 6	1,1	1,5	0
3	20 gram	3,8	3,2	4,4	0,2
4	30 gram	4,2	3,9	3,7	3,4

Table 1 shows the growth in different stem heights for each treatment and repetition. Based on stem height data, it can be seen that the most optimal growth for each treatment occurred in the first repetition. Meanwhile, in the 4th repetition, it was seen that the growth in stem height was not optimal and some even did not grow. This is a concern and requires further analysis.

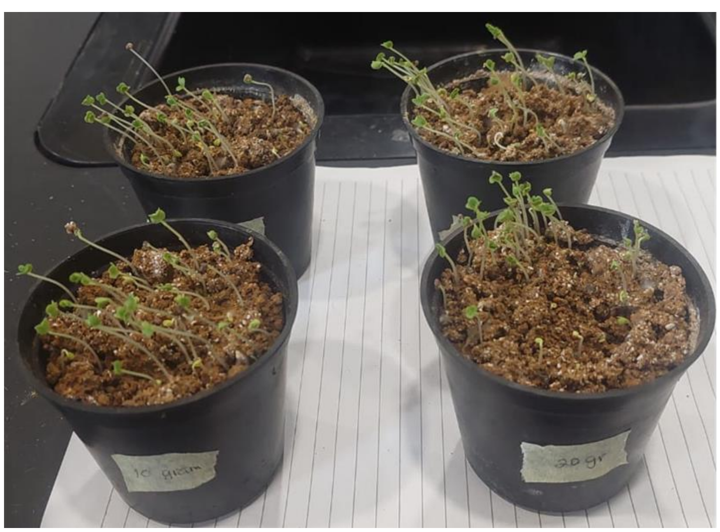

Figure 1. Plant Results with 10 gram Treatment

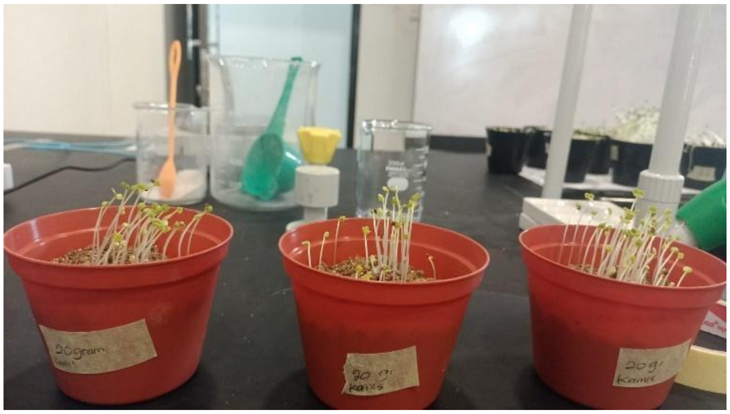

Figure 2. Plant Results with 10 gram Treatment

Figures 1 and 2 show the height of the stems that grew after being planted for 4 days. Relationship between shell concentration and mustard plant stem height after 4 days of planting. FTIR analysis was carried out outside ITEBA due to inadequate equipment. Apart from the observation results, FTIR analy Overall it was proven that the sample contained $CaCO_3$ with a peak of 2926 C-H bonds then 707, 1453.59 contained O-C-O, this is in line with previous research sis was also carried out to determine the functional groups of the pigeon shell powder samples (Noah et al., 2017).

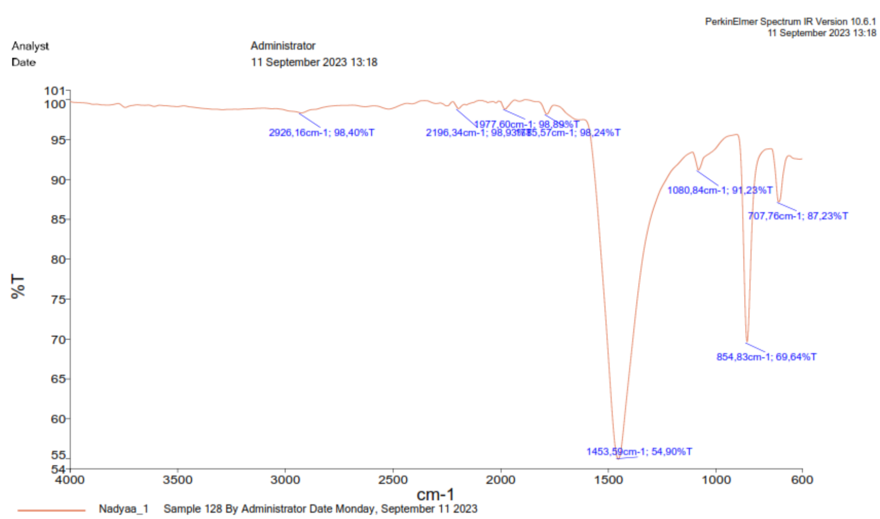

Figure 3. FTIR analysis

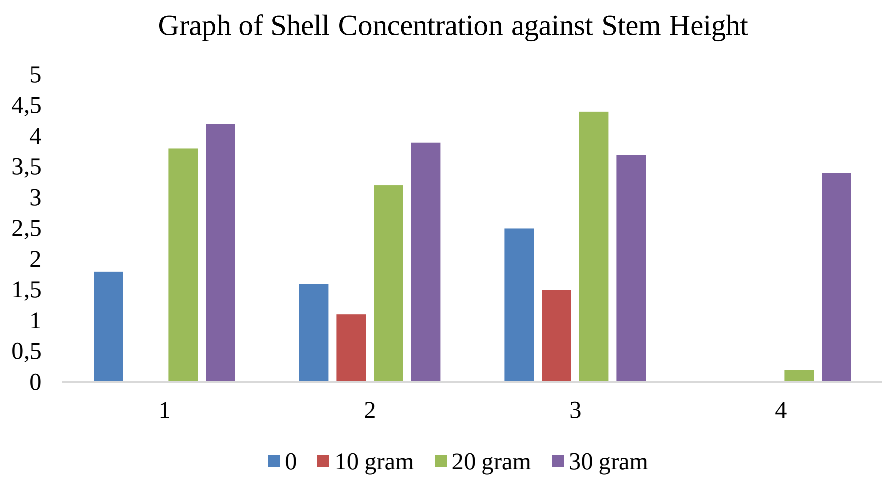

Figure 4. Graph of Shell Concentration against Stem Height

Quantitatively, the mixing of cockle shell powder into ultisol soil had a significant impact on the growth in height of mustard green vegetable stems. From the 4 treatments given, it can be seen that the higher the concentration of the shell powder mixture, the higher the growth of the vegetable stems. This shows a linear relationship between the application of shell powder and the growth of the vegetable plants. However, a different situation occurred in the 4th data repetition. In the 4th repetition, most of the plants did not grow well, and some did not grow at all. At a concentration of 30 grams, the stem height only reached 0.2 cm, and at shell powder concentrations of 0 and 10 grams, the plants did not grow at all. This needs to be further examined regarding the process of mixing the shell powder with the soil. To ensure the nutrient content due to the application of shell powder, it is necessary to measure the nutrient levels in the soil before and after the application of shell powder.

An analysis of variance will be carried out to determine the differences between each treatment of cockle shell powder application on ultisol soil type, which will be applied to green mustard plants. The hypothesis for testing this is:

H_0 : There was no significant difference in treatment when applying virgin cockle shell powder to Ultisol soil

H_1 : There was a significant difference in the treatment of applying virgin kerrang shell powder to Ultisol soil

The following descriptive results carried out using SPSS software can be seen in Table 2.

Table 2. Descriptive Analysis Results

Stem Height	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0 gram	4	1.4750	1.05633	.52817	-.2059	3.1559	.00	2.50
10 gram	4	1.3000	1.07393	.53697	-.4089	3.0089	.00	2.60
20 gram	4	2.9000	1.86548	.93274	-.0684	5.8684	.20	4.40
30 gram	4	3.8000	.33665	.16833	3.2643	4.3357	3.40	4.20
Total	16	2.3688	1.52040	.38010	1.5586	3.1789	.00	4.40

Based on the standard deviation values in table 2 above, a mixture of 20 grams of blood cockle shell powder in the ultisol soil type is more heterogeneous than the mixture in other mixtures. This can be seen from the size of the resulting standard deviation value.

Table 3. Results of Analysis of Variance

Stem Height	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	17.087	3	5.696	3.886	.037
Within Groups	17.588	12	1.466		
Total	34.674	15			

Based on the results of the analysis of variance, the sig value is obtained. equal to 0.037 < α = 5% (0.05), so reject H0. This means that there is a significant difference in treatment for applying blood cockle shell powder to the ultisol soil type, which will be applied to green mustard greens.

CONCLUSION

Based on the research that has been conducted, it can be concluded that blood cockle shells as waste from seafood restaurants have beneficial uses for plants to fertilize crops. Additionally, based on the results of the analysis of variance, a sig. value of 0.037 < α = 5% (0.05) was obtained. Thus, reject H0. This means that there are significant differences in treatment effects from the application of blood cockle shell powder on ultisol soil type, which will be applied to green mustard plants.

From the research that has been conducted, further study is needed on the potential use of blood cockle shell waste in broader agricultural applications: Research can be conducted to test the effectiveness of blood cockle shell powder on other soil types besides Ultisols, such as alluvial soils, volcanic soils, or other acidic soils.

The implication of this research is in the context of developing sustainable agricultural practices as an organic fertilizer. This could include incentives or subsidies for the seafood industry to properly manage blood cockle shell waste, as well as training programs for farmers on the application of organic fertilizer from blood cockle shells. This can increase soil productivity and reduce dependence on chemical fertilizers which can have negative environmental impacts. The seafood industry can develop a centralized collection and processing system for blood cockle shells.

ACKNOWLEDGEMENT

The author would like to thank the Batam Institute of Technology (ITEBA) which has supported the implementation of this research in terms of funding and use of facilities in the form of a basic chemistry laboratory. The author would also like to thank the Institute for Research and Community Service (LPPM) ITEBA which has facilitated the implementation of this research through a lecturer research scheme with an assignment letter No. 024/ST/LPPM-ITEBA/VI/2022.

REFERENCES

Akbar, F., Kusumaningrum, R., Jamil, M. S., Noviyanto, A., Widayatno, W. B., Wismogroho, A. S., & Rochman, N. T. (2019). Sintesis Ca2P2O7 dari Limbah Kerang sebagai Bahan Baku Limbah Cangkang Kerang dengan Metode Solvothermal. *Jurnal Fisika Dan Aplikasinya*, *15*(3), 110. https://doi.org/10.12962/j24604682.v15i3.4707

Amri, A. A., Shorea, Z., Pujiastuti, C., Sumada, K., & Muljani, S. (2022). *Pengaruh Derajat Keasaman (pH) Dalam Presipitasi Kalsium Oksida dari Cangkang Kerang Darah*. 2020–2023.

Azzahro, Umei Latifah, W. B. (2021). *Pemanfaatan Limbah Cangkang Kerang Dara Sebagai Katalis Cao Pada Pembuatan Biodiesel Minyak Goreng Bekas*. *1*(6), 499–507.

Balqies, S. C., Prijono, S., & Sudiana, I. M. (2018). Pengaruh Zeolit dan Kompos Terhadap Retensi Air, Kapasistas Tukar Kation, dan Pertumbuhan Tanaman Sorgum (Sorghum bicolor (L.) Moench) pada Ultisol. *Jurnal Tanah Dan Sumberdayalahan*, *5*(1), 755–764.

Chemmalar, S., Intan-Shameha, A. R., Abdullah, C. A. C., Razak, N. A. A., Yusof, L. M., Ajat, M., Gowthaman, N. S. K., & Bakar, M. Z. A. (2021). Synthesis and characterization of gefitinib and paclitaxel mono and dual drug-loaded blood cockle shells (Anadara granosa)-derived aragonite caco3 nanoparticles. *Nanomaterials*, *11*(8), 1–32. https://doi.org/10.3390/nano11081988

Fazrina & Winda Yursilla. (2019). *Pemanfaatan Limbah Cangkang Kerang Darah (Anadara Granosa) Sebagai Pupuk Organik Terhadap Pertumbuhan Tanaman Sawi (Brassica Juncea)*. *VIII*(2), 25–33.

Gani, R. A., Purwanto, S., & Sukarman, S. (2021). Karakteristik Tanah Vulkanik di Kabupaten Wonosobo dan Pengelolaannya untuk Pertanian. *Jurnal Tanah Dan Iklim*, *45*(1), 1. https://doi.org/10.21082/jti.v45n1.2021.1-11

Juliutomo, D., Mirawati, B., & Imran, A. (2018). *Media Tanam Campuran Limbah Cangkang Kerang Mutiara (Pinctada maxima) untuk Pertumbuhan Tanaman Jagung (Zea mays)*. *5*(1), 49–57.

Mekar, P., & Insani, S. (2021). *Analisis Pola Struktur Kalsium Karbonat (CaCO 3) pada Cangkang Kerang Darah (Anadara granosa) di Bukit Kerang Kabupaten Aceh Tamiang Indonesia merupakan negara yang terdiri Universitas Negeri Malang dengan*. *09*(01), 23–32.

Mtavangu, S. G., Mahene, W., Machunda, R. L., van der Bruggen, B., & Njau, K. N. (2022). Cockle (Anadara granosa) shells-based hydroxyapatite and its potential for defluoridation of drinking water. *Results in Engineering*, *13*(January), 100379. https://doi.org/10.1016/j.rineng.2022.100379

Nayan, A., Hafli, T., Teknik, J., & Univesitas, M. (2022). *Analisa Stuktur Mikro Material Komposit Polimer Berpenguat*. *6*(1), 15–24.

Noah, A. Z., El Semary, M. A., Youssef, A. M., & El-Safty, M. A. (2017). Enhancement of yield point at high pressure high temperature wells by using polymer nanocomposites based on ZnO & CaCO3 nanoparticles. *Egyptian Journal of Petroleum*, *26*(1), 33–40. https://doi.org/10.1016/j.ejpe.2016.03.002

Noorma Kurnyawaty1), Fitriyana1), Fataa Kusumattaqiin1), Rizky Sulvika Puspa Rinda2), A. A. (2020). *Identifikasi Potensi Cangkang Kerang Darah Lokal Desa Kutai Lama Dan Pemanfataannya Untuk Penurunan Kadar Logam Besi (Fe^{2+})*. 17–22.

Pungut, & Widyastuti, S. (2019). *Kadar Kalsium Kerupuk Samiler Fortifikasi Nano Kalsium Dari Cangkang Kerang Darah (Anadara granosa liin)*. 589–596.

Setiawan, B., Hermanto, S. R., Studi, P., Tanaman, B., Politeknik, P., & Ketapang, N. (2021). *Aplikasi biochar sekam padi dan tepung cangkang kerang ale-ale untuk memperbaiki sifat kimia tanah sulfat masam*. *14*(1), 55–60.

Sinurat, E., Dewi, F. R., Fransiska, D., & Nurbayasari, R. (2022). Synthesis and Characterization of Hydroxyapatite of Cockle Shells (Anadara granosa) Originated from Indonesia Through Precipitation Method. *IOP Conference Series: Earth and Environmental Science*, *1118*(1). https://doi.org/10.1088/1755-1315/1118/1/012035

Siregar, M. J., & Nugroho, A. (2021). Aplikasi Pupuk Kandang Pada Tanah Merah (Ultisol Soil)

Di Lahan Pertanian Batam, Kepulauan Riau. *Jurnal Serambi Engineering*, *6*(2), 1870–1878. https://doi.org/10.32672/jse.v6i2.2888

Sudarmawan, W. S., Suprijanto, J., & Riniatsih, I. (2020). *Abu Cangkang Kerang Anadara granosa , Linnaeus 1758 (Bivalvia : Arcidae) sebagai Adsorben Logam Berat dalam Air Laut*. *9*(3), 237–244.

Sulistiyaningsih, E., & Arbi, U. Y. (2020). Aspek Bio-Ekologi Dan Pemanfaatan Kerang Marga Anadara (Mollusca: Bivalvia: Arcidae). *Oseana*, *45*(2), 69–85. https://doi.org/10.14203/oseana.2020.vol.45no.2.95

Tasari, F. T. (2022). *Analisis Cangkang Kerang Darah (Anadara granosa) sebagai Sumber CaCO 3 pada Pembuatan Ubin Keramik Dinding*. *10*(3), 352–359.