Jurnal Akademika Kimia, 13(3): 78-81, August 2024
ISSN (online) 2477-5185 | ISSN (print) 2302-6030
http://jurnal.fkip.untad.ac.id/index.php/jak/

OPEN ACCESS

Analysis of calcium (Ca) and phosphorus (P) levels in meti shells (Batissa violacea L.)

***Yadi Sumarsono, Baharuddin Hamzah, & Reny**
Program Studi Pendidikan Kimia/FKIP – Universitas Tadulako, Palu – Indonesia 94119

Received 03 June 2024, Revised 13 June 2024, Accepted 18 June 2024
doi: 10.22487/j24775185.2024.v13.i3.pp78-81

Abstract

Meti clams (Batissa violacea L.) are one of the types of shellfish that live in freshwater. Shell waste contains high levels of calcium carbonate (98% by weight) and has potential for utilization. This research aims to determine the calcium (Ca) and phosphorus (P) levels in meti shells (Batissa violacea L.) from Woomparigi Village, North Morowali Regency. Analysis of calcium levels (Ca) using an atomic absorption spectrophotometer (AAS) at wavelengths of 422.7nm and phosphorus levels (P) using a UV-Vis spectrophotometer at a wavelength of 590nm. The results show that the average concentration of Calcium (Ca) is 14.58%, while the average concentration of Phosphorus (P) is 2.01%.

Keywords: Batissa violacea l., calcium, meti clams, phosphorus, sell

Introduction

Clams are the name of a group of bivalve mollusks from the Cardiidae family, which is one of the fishery commodities that have long been cultivated as a side business for coastal communities (Moore et a., 2021). Clam shells contain several minerals, including calcium, which is needed by the human body. Shell waste has been primarily used as craft materials, such as wall hangings and interior designs (Nurjanah et al., 2021).

The freshwater mussel (Batissa violacea L. von Lamarck, 1818) is one of the species of animals from the Bivalve class (Kroini et al., 2021). This type of mussel is found in abundance in the Tokala River, North Bungku Sub-District, North Morowali District, Central Sulawesi. Local people widely use this freshwater clam for consumption and sale as a source of livelihood. According to Gökoğlu (2021), methi mussel shells contain 1.298 ppm cobalt, 2.734 ppm copper, 122.406 ppm iron, 53.432 ppm manganese, and 0.896 ppm zinc.

Methi clam (Batissa violacea L.) is one type of clam that lives in freshwater. The shells contain calcium carbonate ($CaCO_3$). This can be seen from the hardness of the shell. The harder the shell, the higher the calcium carbonate content (Fahmiati et al., 2024). Clam shells contain higher levels of calcium carbonate ($CaCO_3$) than limestone, eggshells, ceramics, or other materials. Clam shell waste contains high levels of calcium carbonate (98% by weight), which has potential for utilization. The high concentration of calcium carbonate in clam shells is reflected in their hardness. The harder the shell, the higher the calcium carbonate content (Setyowati, 2016).

The macro mineral content of freshwater mussel shells from the Riau area is calcium 31.25%, sodium 3.62%, potassium 3.24%, phosphorus 0.33%, and magnesium 0.29%. While the highest micro mineral levels of iron and zinc were 2.54% and 0.91%, respectively (Khairiyah et al., 2022).

In addition to their comparatively high macro- and micromineral content, freshwater mussel shells are predominantly composed of calcium carbonate ($CaCO_3$), which plays a vital role in determining their mechanical strength and hardness. Because of its high $CaCO_3$ content, mussel shell waste is a viable natural calcium source for a number of uses, such as fertilisers, adsorbents, catalysts, biomaterials, and a precursor for the manufacture of hydroxyapatite (Srichanachaichok & Pissuwan, 2023). According to earlier research, mussel shells have a calcium carbonate content of up to 98% by weight, which is higher than that of several other calcium sources, including limestone and eggshells (Hart, 2020).

This high mineral concentration suggests that mussel shell waste has significant potential as a value-added raw material for a variety of industrial and environmental applications, as well as to reduce environmental pollution associated with shell disposal (Summa et al., 2022). Based on this reason, the purpose of this study is to determine calcium

*Correspondence:
Yadi Sumarsono
e-mail: sumarsonoyadi@gmail.com

(Ca) and phosphorus (P) levels in meti shells (Batissa violacea L.).

Methods

Tools and materials

The tools used in this research are GBC 932 AA Atomic Absorption Spectrophotometer (SSA), UV-Vis Spectrophotometer, dropper pipette, vaporizer cup, gegep, filter paper, funnel, spray bottle, 10 mL measuring cup, 25, 50, 100, and 1000 mL volumetric flask, 50 mL beaker, stirring rod, spatula, MMM Medcenter oven, FB1410M furnace, and ARC-120 digital balance. The materials used in this study were methi freshwater mussel shells (Batissa Violacea L.), clean water, distilled water, 65% concentrated HNO_3 solution (E-Merck), calcium nitrate ($Ca(NO_3)_2$) mother liquor (Ajax Chemicals), monopotassium phosphate (KH_2PO_4) mother liquor (E-Merck), hydrochloric acid (HCl), filter paper, and tissue.

Determination of ash content

A 10-gram sample of methi shells was placed in a vaporizer cup whose weight was known using a digital balance. The methi mussel shells were then fumigated in a furnace at 700°C for 3 hours, producing a grayish ash, which was cooled in a desiccator, weighed, and the ash content was determined. The sample was then determined by using the following formula (Yatsin et al., 2022).

$$\% \text{ Ash content} = \frac{\text{Ash weight}}{\text{Dry weight}} \times 100\% \qquad (1)$$

Sample preparation for analysis

The methi shell ash sample was weighed at 10 grams, added concentrated HNO3 little by little until the sample dissolved, then filtered until the filtrate and residue were separated. In this study, only the filtrate was taken, and the residue was not used. The obtained filtrate was diluted with distilled water in a 100 mL volumetric flask to the mark (Sumarlin et al., 2024).

Preparation of calcium and phosphorus standard solutions 1000 ppm → 100 ppm

10 mL of the prepared calcium and phosphorus solution was transferred into a 100 mL volumetric flask and made up to the mark with distilled water (Suarsa et al., 2020).

Calibration Curve Creation

Calcium and phosphorus standard solutions at 100 ppm are used to prepare a standard series at 5, 10, 15, 20, and 25 ppm. Fill a 100 mL volumetric flask with each standard solution of calcium and phosphorus at 100 ppm, in volumes of 5, 10, 15, 20, and 25 mL, and dilute with distilled water to the mark. Then measure the absorbance at 422.7 nm for calcium and at 590 nm for phosphorus, and create linear regression equations and calibration curves in Microsoft Excel (Zakiyah et al., 2019).

Calcium Content Analysis by SSA

The prepared sample solution is taken in a 1 mL volumetric flask and diluted with distilled water to the mark in a 100 mL volumetric flask. Calcium content in the sample solution was determined by measuring its absorption with an atomic absorption spectrophotometer. Calcium metal was measured at a wavelength of 422.7 nm (Sumarlin et al., 2024).

Phosphorus Level Analysis with UV-Vis Spectrometer

The prepared sample solution is taken in a 2 mL volumetric flask and diluted with distilled water to the mark in a 50 mL volumetric flask. The phosphorus level in the sample solution was determined by measuring its absorption with a UV-Vis spectrophotometer. Metal phosphorus was measured at a wavelength of 590 nm (Hesti et al., 2023).

Results and Discussion

The results of the research on the determination of calcium and phosphorus levels in methi mussel shells (Batissa violacea L.) include data on moisture content, ash content, standard solution absorption, and calcium and phosphorus concentrations determined by Atomic Absorption Spectrophotometry (AAS) and UV-Vis spectrophotometry; these are presented in **Table 1**.

Table 1. Average data of moisture content and ash content in methi mussel (Batissa violacea L.) shell samples.

No.	Methi clam shell sample	
1	Water content	0.46 %
2	Ash content	95.27 %

The absorbance measurements of 5-25 ppm calcium and phosphorus standard solutions (mg/L) are shown in **Tables 2** and **3**.

Table 2. Absorbance of phosphorus standard solution 5 - 25 ppm)

No	Concentration (ppm)	Absorbance
1	5	0.003
2	10	0.026
3	15	0.056
4	20	0.081
5	25	0.105

Table 3. Absorbance of the calcium standard solution 5 - 25 ppm

No	Concentration (ppm)	Absorbance
1	5	0.146
2	10	0.247
3	15	0.337
4	20	0.439
5	25	0.560

Calcium and phosphorus calibration curves were obtained from absorbance measurements of standard solutions of these elements in **Tables 2 and 3**. From the linear regression program, linear regression equations were obtained for calcium ($Y = 0.0204x + 0.0398$; $r = 0.9973$) in **Figure 1** and for

phosphorus (Y = 0.0052x - 0.0235; r = 0.9984) in **Figure 2**.

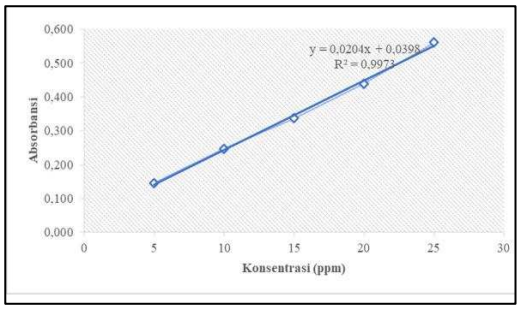

Figure 1. Calcium (Ca) standard curve

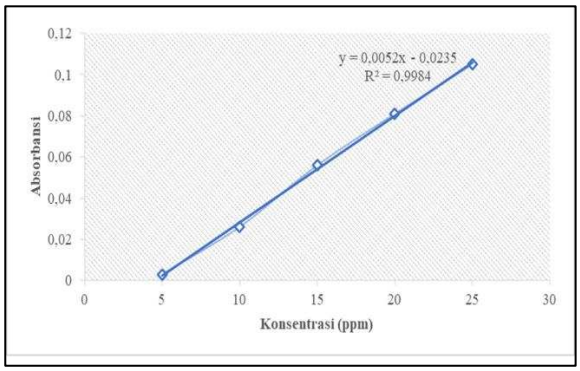

Figure 2. Phosphorus (P) standard curve

Based on the dilution factor calculation, the calcium and phosphorus concentrations in the dried methi shell samples are shown in **Tables 4** and **5**.

Table 4. Calcium concentration in meti clam shells

Sample	Treatment	Absorbance	Concentration Ca	
			(ppm)	%
Cangkang kerang	I	0.344	15.250	-
	II	0.339	15.000	-
	III	0.353	15.700	-
Average		**0.345**	**15.317**	**14.58**

Table 5. Phosphorus concentration in clam shells methi

Sample	Treatment	Absorbance	Concentration P	
			(ppm)	%
Cangkang kerang Meti	I	0.017	8.000	--
	II	0.021	8.800	--
	III	0.020	8.600	--
Average		**0.019**	**8.467**	**2.01**

Ash content is determined using the dry ashing method. The principle of this analysis is to oxidize all organic substances at high temperatures (around 550°C), then weigh the substances left behind after the combustion process (Basrin, 2020)

Ash content is obtained by comparing the ash weight to the sample's initial weight, then multiplying by 100%. The ash content of the methi mussel shell sample was 95.27%. After determining the ash content of the sample, the resulting ash was dissolved by adding concentrated HNO_3. After that, it is added to distilled water, then filtered and diluted with distilled water in a 100 mL volumetric flask until the sample volume reaches exactly the limit mark. The purpose of adding concentrated nitric acid is to dissolve the metals to be analyzed and oxidize residual organic compounds from the sooting process (Sumarlin et al., 2024).

Calcium (Ca) levels in clam shell samples were obtained using atomic absorption spectrophotometry (SSA) with a cathode lamp appropriate to the type of metal to be analyzed. The sample solution was measured at a wavelength of 422.7 nm. This atomic absorption spectrophotometer is selected because it has high sensitivity, is fast, is specific to the element being determined, and can measure very low concentrations in the sample. In addition, analysis using SSA enables simultaneous determination of several types of minerals/metals in a material (sample), as the absorbance or emission of each metal can be measured at specific wavelengths corresponding to its type (Ramadani, 2021).

Based on the analysis and calculation results, taking into account the dilution factor, the calcium content in the shells of Methi (Batissa violacea L.) was found to be 14.58%, calculated on a dry weight basis. Calcium levels in other shells vary greatly depending on the type of shell and the sampling location. Green clam shells (Perna virdis) have a calcium content of 34.93 (Kurnyawaty et al., 2021); blood clam shells (Anadara granosa) vary between 30% and 70%. (Larasati et al. 2022) Moreover, pearl clam shells (Pinctada margaritifera) have levels of 2.54% to 3.63% (Kalesaran et al., 2018).

Phosphorus levels in the samples were analyzed using a UV-Vis spectrophotometer at a wavelength of 590 nm. The UV-Vis spectrophotometer is a spectroscopic analysis technique that uses near-ultraviolet (190-380 nm) and visible (380-780 nm) light sources. Therefore, the sample solution to be analyzed must be colored.

Based on the results of analysis and calculation, taking into account the dilution factor, the phosphorus content in the shells of Methi (Batissa violacea L.) is 2.01%, calculated on a dry weight basis. When compared with other shells, this result is quite high. Simping (Placuna placenta) shells contain phosphorus (P) levels of 0.0054%, and blood clam shells (Anandara granosa) 0.00049% (Ramadani, 2021).

Conclusions

Based on the results of the research and discussion that have been presented, the research on the analysis of calcium and phosphorus levels of Meti clam shell waste (Batissa violacea L.) caught by the people of Woomparigi village, North Morowali district in Tokala River can be concluded: The analysis showed that the shells of Meti (Batissa violacea L) contain chemical elements and

compounds, namely Ca content and P content of 14.58% and 2.01%, respectively.

Acknowledgment

The authors would like to thank the laboratory assistants at the FKIP Chemistry Laboratory and the MIPA Chemistry Laboratory, Tadulako University, as well as all those who helped with the implementation of this research.

References

Basrin, F. (2020). Pengaruh substitusi tepung terigu dengan tepung sukun (artocarpus altilis) terhadap mutu kimia kue semprong. *Jurnal Pengolahan Pangan, 5*(1), 7–14. https://doi.org/10.31970/pangan.v5i1.31

Fahmiati, Mimiati, W. O., Kadir, L. A., & Armid. (2024). Innovative use of hydroxyapatite (hap) from pokea clam shells (batissa violacea var. celebensis) for toothpaste manufacturing. *Engineering and Technology Journal, 9*(11), 5482–5488. https://doi.org/10.47191/etj/v9i11.04

Gökoğlu, N. (2021). Molluscan Shellfish. In Gökoğlu, N. (Eds.). *Shellfish Processing and Preservation* (pp. 129–250). Swiss: Cham. https://doi.org/10.1007/978-3-030-60303-8_3

Hart, A. (2020). Mini-review of waste shell-derived materials' applications. *Waste Management & Research*, *38*(5), 514–527.

Hesti, Rahmanpiu, & Rudi, L. (2023). Penentuan kadar NPK (nitrogen, fosfor dan kalium) dari pelepah aren (arenga pinnata m.). *Jurnal Kimia dan Pendidikan Kimia, 12*(1), 50–56. https://doi.org/10.36709/sains.v12i1.33

Kroini, H., Hamdani, A., Soltani, N., Zaidi, N., & Sleimi, N. (2021). Effects of cadmium exposure on proximate analysis and metallic element contents of wedge clam (Donax trunculus). *Applied Ecology & Environmental Research*, *19*(6), 5104-5128.

Kurnyawaty, N., Fitriyana, F., Taufik, M., & Putri, A. E. (2021). Penurunan kadar logam besi menggunakan bubuk kalsium cangkang kerang hijau. *Jurnal Teknik Kimia Vokasional, 1*(1), 10–14. https://doi.org/10.46964/jimsi.v1i1.656

Nurjanah, Abdullah, A., Hidayat, T., Seulalae, A. V. (2021). *Moluska: Karakteristik, potensi dan pemanfaatan sebagai bahan baku industri pangan dan non pangan*. Aceh: Syiah Kuala University Press.

Moore, D., Heilweck, M., & Petros, P. (2021). Saving the planet with appropriate biotechnology: 2. Cultivate shellfish to remediate the atmosphere. *Mexican Journal of Biotechnology*, *6*(1), 31–91.

Kalesaran, O. J., Lumenta, C., Rompas, R., & Mamuaya, G. (2018). Komposisi mineral cangkang kerang mutiara pinctada margaritifera di Sulawesi Utara. *E-Journal Budidaya Peraian, 6*(1), 25–30. https://doi.org/10.35800/bdp.6.1.2018.24126

Khairiyah, Z., Fatma, F., Kabangnga, A., & Fitriyani, F. (2022). Characteristics of the windowpane oyster flour mineral content (placuna placenta linnaeus, 1758). *Jurnal Airaha*, *11*(01), 151–156. https://doi.org/10.15578/ja.v11i01.205

Larasati, D., Nurtanto, D., & Utami, N. M. (2022). Effect of duck egg shell ash with fly ash as cement substitution in geopolymer concrete. *Berkala Sainstek, 10*(2), 51-57. https://doi.org/10.19184/bst.v10i2.29080

Ramadani, S. (2021). *Kandungan kalsium dan fosfor pada cangkang kerang simping (placuna placenta) dan kerang darah (anadara granosa) yang berasal dari perairan Pesisir Banyuasin, Sumatera Selatan*. Unpublished undergraduate's thesis. Palembang: Universitas Sriwijaya.

Setyowati, M., & Chairudin. (2016). Kajian limbah cangkang kerang sebagai alternatif bahan amelioran di lahan gambut. *Jurnal Agrotek Lestari, 2*(1), 59-64. https://doi.org/10.35308/jal.v2i1.496

Srichanachaichok, W., & Pissuwan, D. (2023). Micro/Nano structural investigation and characterization of mussel shell waste in Thailand as a feasible bioresource of CaO. *Materials*, *16*(2), 1–11.

Suarsa, I. W., Bawa, P. A. A., Santi, S. R., & Faruk, A. (2020). Produksi tepung tulang ikan tuna (thunnus sp) dengan metode kering sebagai sumber kalsium dan fosfor untuk pembuatan biskuit. *Jurnal Ilmu Pendidikan Indonesia, 8*(1), 19–28. https://doi.org/10.31957/jipi.v8i1.1132

Sumarlin, L. O., Zidni, A. O. N., Nurhasni, Hendrawati, & Wulandari, M. (2024). Kadar logam merkuri (Hg) dan batas aman konsumsi kerang hijau (perna viridis l.) di Kalibaru Timur dan Muara Kamal. *Jurnal Ilmu Lingkungan, 22*(1), 264–269. https://doi.org/10.14710/vol%viss%ipp%p

Summa, D., Lanzoni, M., Castaldelli, G., Fano, E. A., & Tamburini, E. (2022). Trends and opportunities of bivalve shells' waste valorization in a prospect of circular blue bioeconomy. *Resources*, *11*(5), 1-16.

Yatsin, H., Isamu, K. T., & Herdiansyah, D. (2022). Pengaruh lama perebusan terhadap nilai sensori dan komposisi proksimat kerang pokea (batissa violacea var celebensis, von martens 1897). *Journal Fish Protech, 5*(2), 12–26. https://doi.org/10.33772/jfp.v5i2.28392

Zakiyah, Z. N., Rahmawati, C., & Fatimah, I. (2019). Analysis of phosphorus and potassium levels in organic fertilizer in the integrated laboratory of Jombang District Agriculture Office. Indonesian *Journal of Chemical Research, 3*(2), 38–48. https://doi.org/10.20885/ijcr.vol3.iss2.art1