Potential of Shells as a Source of Calcium

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Abstract

Shellfish are also known as by-products, namely production results that are not utilized or not consumed, where the value of this by-product can be increased/added through a process known as Reduce-Reuse and Recycle (3R). This research aims to determine shellfish's potential as a calcium source. Samples of clams (*Paphia undulata*), blood clams (*Tegillarca granosa*), and Asian Moon Scallop (*Amusium pleuronectes*) were obtained from Tambak Lorok Fish Auction Place, Semarang. The shell fluor was analyzed for Calcium and mineral content using the XRF method at the Integrated Laboratory, Universitas Diponegoro. The results of the study showed that the Calcium (CaO) content of the three shellfish was the lowest in the clam (*P. undulata*) at 45.79%, then the Asian moon Scallop (*A. pleuronectes*) at 45.89%, and the highest in the blood cockle *T. granosa* namely 92.41%. It can be concluded that the shells of clams, blood clams, and Asian Moon Scallops contain high levels of calcium and minerals, which have the potential to be used as an additional ingredient in concrete/paving blocks and fish feed.

Keywords: *Amusium pleuronectes, by-product*, calcium, *Paphia undulata, Tegillarca granosa,*

INTRODUCTION

Mollusks make a significant contribution to the world's marine products. Marine bivalves, abundant in coastal waters and estuaries, can be exploited in large quantities using traditional methods and sold directly on the market for human consumption. Economically important species of marine bivalves are green mussels (*Perna viridis*), oysters (*Crassostrea* sp), and clams (*Meretrix* sp) (Chatterji *et al*., 2002). The part of shellfish that people usually consume is the meat or soft tissue. The other parts that are not consumed, called by-products, are generally fish or parts of fish (crustaceans, cephalopods, mollusks) not conventionally consumed (skin, bones, head, viscera, shell) but recoverable and used after treatment (Ifremer, 2010). The shell is usually used as a craft and jewelry material. However, these shells are in vast quantities. In that case, they can cause piles of shell waste to pile up and become mountains, such as in Wonosari Village, Brebes Regency, which disturbs the aesthetics (Suprijanto *et al*., 2008), and also in Wedung Village, Demak Regency. This shell is also called a by-product: production results that are not utilized. The value of this by-product can be increased/added through a process known as Reduce-Reuse and Recycle, also known as the 3 R's (Adewuyi *et al*., 2015).

Efforts towards optimizing the use of marine by-products, for example, shellfish, including through the shell. The use of shellfish shells can still be improved towards resource management that does not leave residual material or waste. Resource management is based on zero waste management, using resources without leaving any remaining waste. This can be done by using shells in other products with added value. Shellfish shells are formed through biomineralization and consist mainly of CaCO3 with a small amount of organic matrix, so they have the potential to be used as raw materials. Recycling shell waste can eliminate disposal problems and convert useless waste into high-value-added products (Yao *et al*., 2014). From these shell by-products, the added value can be increased, including making dry cakes or cookies (Agustini *et al*., 2011), liquid fertilizer (Umami, 2013), or adding it to milk (Windarto *et al*., 2013), as a substitute material for making paving blocks (Suprijanto *et al*., 2020), and fish feed (Ashuri *et al*., 2021).

The utilization of marine by-products can be integrated through empowering fishing

Diterima/Received : 05-12-2023
DOI:10.14710/buloma.v13i1.61977 Disetujui/Accepted : 01-02-2024

communities, coupled with support from the government, academics, or related parties, through the transfer of appropriate or simple technology in efforts to utilize and add added value to sustainable marine product by-products. This research aims to examine the potential utilization of marine by-products from clam (*Paphia undulata), blood clams (Tegillarca granosa)* and Asian moon scallop *(Amusium pleuronectes*) shells to support the Reduce Reuse and Recycle (3R) program.

MATERIAL AND METHODS

Samples of clam (*Paphia undulata),* blood clams *(Tegillarca granosa),* Asian moon scallop *(Amusium pleuronectes*) were obtained from Fish Auction Place at Tambak Lorok, Semarang. Next, the three shellfish samples were taken to the Marine Biology Laboratory, Faculty of Fisheries, Marine Science, Universitas Diponegoro to have their shells taken and air-dried until dry.

Flour Making Process

The shells of the three species of shellfish were dry and then ground using a shell breaker, a Hammer Mill, at the Marine Biology Laboratory, Faculty of Fisheries and Marine Science, Universitas Diponegoro. The milling results are then filtered using a 0.063 – 2 mm sieve. The flour resulting from the screening is shellfish flour, which is then analyzed for calcium and mineral content.

Analysis of Calcium Content in Shell Flour

Calcium and mineral content analysis in feed was carried out using the X-Ray Fluorescence method (Rigaku Supermini200) at the Integrated Laboratory, Universitas Diponegoro. XRF is an analysis carried out based on the identification and enumeration of the characteristics of X rays that occur from photoelectric effect events to search for or identify the content of oxide elements in natural materials, namely shellfish flour; especially as a source of calcium and minerals (Munasir *et al*, 2012).

RESULTS AND DISCUSSION

The results of the analysis of calcium and mineral content in shell flour are presented in Table 1. Table 1 shows that the calcium (CaO) content of the three shellfish is the lowest in the clam (*Paphia undulata)* at 45.79%, then the Asian moon scallop *(A. pleuronectes*) at 45.89%, and the highest in the blood clam *T. granosa*, namely 92.41%. The calcium content in the blood cockle *T. granosa* is higher than other shellfish, such as the *Cerastoderma edule* clam, namely 57.95% Adewuyi *et al*. (2015). The researcher used *C. edule* shells as a substitute material for making concrete. Considering that the calcium content in the blood cockle *T. granosa* is higher than *C. edule*, the blood cockle has the potential to be used as a substitute material for concrete. Apart from using materials from *C. edule* shells, Adewuyi *et al*. (2015) also used the gastropod *Littorina littorea* as a substitute material for making concrete, which contains 55.53% calcium.

Furthermore, Adewuyi *et al*. (2015) said that the calcium content in shells, silicates, and aluminum is useful in concrete as a reinforcing material to produce concrete with better resistance to compressive strength tests. Liemawan *et al*. (2015) further stated that green mussel shells (*Perna viridis* L.) could substitute cement in making mixed concrete. Using shellfish as a material for concrete, paving blocks is very effective in managing shellfish by-products because shell material is required in large quantities.

Apart from having the potential as a substitute material for concrete and paving blocks; shellfish's calcium and mineral content can be used as an additional ingredient for fish feed. Fish feed requires specific nutrients that will help optimize growth; while increasing the profits of the cultivation business. Apart from that, minerals are also needed in the composition of the fish feed. According to Pandey (2013), minerals can include around 20 inorganic mineral elements, including calcium, phosphorus, magnesium, iron, copper, manganese, zinc, iodine, and selenium. Mahary (2017), explained in the use of blood cockle shell (*Anadara granosa*) as a source of calcium in catfish (*Clarias batrachus*) feed that by adding blood cockle to catfish feed; the highest survival rate was found in the treatment with the addition of *Anadara granosa* shell by 10 %.

The survival results of the catfish rearing experiment were 52%. The weight increase was 1.55 gr, and the length increase was 1.82 cm. As a source of calcium, shellfish ranging from 25.40 to 36.30 mg/kg/wet can also be found in *Pinctada margaririfera* shell flour (Kalesaran & Lumenta, 2018).

Ferraro *et al*. (2010) stated that seafood by-products could become feed products in aquaculture, including making fish feed by processing

Table 1. Results of XRF analysis of the components of clam shell flour (*Paphia undulata),* blood cockles *(Tegillarca granosa*), and Asian moon scallop *(Amusium pleuroctes).*

Component	Shell flour (%)		
	Paphia undulata	*Tegillarca granosa*	*Amusium pleuronectes*
CaO	45.79	92.41	48.49
Al_2O_3	0.18	0.28	-
SiO_2	0.83	0.14	0.49
P_2O_5	0.12	0.18	0.19
SO_3	0.30	0.40	0.83
Cl	0.29	0.88	0.23
K_2O	0.12	0.21	0.05
MnO	0.03	0.14	-
Fe_2O_3	1.19	3.96	0.77
SrO	0.16	0,46	0.14

it into flour. As a raw material for fish feed, shells are leftovers from the production of marine resources, which can be used as a substitute for calcium sources. Making feed for fish is a scheme for utilizing leftover marine products, which can be used to increase added value.

In its application in society and management of marine by-product resources, Bergé *et al*. (2009) and Galvez & Bergé (2009); stated that society does not need high-level technology to achieve the 3 R's. Simple technology is also applied in managing shellfish waste in Thailand and the Philippines (Chilakala *et al*., 2019). Communities in the Britttany area in France are making efforts to utilize marine product remains such as shellfish, fish, and shrimp, namely in the form of shells or scales or carapace; namely, it is used to fertilize agricultural land by the people of Brittany region in France (Benjamin & Manner, 2011). Caruso (2015) further said that about a quarter of marine products are waste. If waste originating from marine products is disposed of, it causes significant environmental pollution and a loss of the product's potential value. Bourseau (2010) puts forward the concept of utilization by providing ways to achieve the expected added value stages, from utilization for agricultural needs to medicinal ingredients.

CONCLUSION

Based on the research results, it can be concluded that the shells of clams, blood clams, and Asian moon scallop contain high levels of calcium and minerals, which have the potential to be used as an additional ingredient in concrete/paving blocks and fish feed; to support the management of shell waste to reduce, reuse and recycle by-products (zero waste management).

ACKNOWLEDGEMENT

The author would like to thank the Faculty of Fisheries and Marine Science Diponegoro University for providing funding for this research through the Research Grant Program, funding sources other than APBN Number: 72/UN7.5.10.2/PP/2021. The author also would like to thank the parties who cannot be mentioned one by one who have helped carry out this research.

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