



UDC 639; DOI 10.18551/rjoas.2022-10.12

HEAVY METAL RESIDUE ON WATER, BIOTA AND SEDIMENT IN NEGARA RIVER

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ABSTRACT

Community activities around the Sungai Negara area will increase the burden of pollutant substances entering the waters. One type of pollutant is heavy metals that will settle at the bottom of the water (sediment), and of course have polluted the water and the biota that live in it. One of the problems that occur is the continued impact of heavy metal pollution in these waters. However, it is not yet known whether the heavy metal residues were found in water, sediment, or fish meat. The purpose of this study was to analyze the content of heavy metals Hg, Cd, Pb, Cr, Fe, Cu and Zn. The method used is a purposive sampling survey method and descriptive method. Heavy metal analysis using the Atomic Absorption Spectrophotometer (AAS) method. The results showed that the content of heavy metals in the water in samples 1 to 3 that did not meet the required quality standards were dissolved Fe, dissolved Cu and Hg. The heavy metal content that exceeds the SNI standard in fish is Cd and Pb, and in sediment is Zn and Pb. The existence of community activities and blacksmiths causes high levels of dissolved Hg and Fe in the water. The high levels of Cu in the waters, Zn and Pb in the sediments are caused by oil palm plantation activities in upstream waters. Meanwhile, the high levels of Cd and Pb in fish meat have become an early warning for the safety of food products sourced from the waters of the Sungai Negara.

KEY WORDS

Heavy metals, sediment, biota, Negara River.

Sungai Negara has complex and diverse aquatic biota, where in almost all water areas there are various types of plankton, fish, and other aquatic organisms and their presence can be observed directly or through a microscope. Currently in Sungai Negara there is a tendency that the condition of water quality has decreased. This is caused by the influence of sea water intrusion, water pollution from domestic waste and pollutants that carry heavy metals (Dwiyitno et al, 2008).



Waters that are contaminated with heavy metals will contribute to the contamination of the basic substrate or sediment, as well as aquatic biota that live in these waters. With the condition of these waters being polluted, it will cause fish with local economic value to become unsafe for consumption. This is a nuisance and can be categorized as pollution, which can harm other aquatic organisms and humans indirectly through the food web concept.

Water is said to be polluted if there is an influence or contamination of organic or inorganic substances into the water. The increase in the number of trace elements (pollutant loads) resulted in the disruption of the stability of water quality parameters, especially the key water quality parameters of river waters. The cases emergence of heavy metal contamination, such as Hg and Pb, in the estuary waters of the Barito watershed (Sofarini et al, 2012) is a warning that these waters have been contaminated with heavy metals..

The content of heavy metals in water bodies, biota and sediments in the waters of Sungai Negara is not clearly known. Therefore, it is necessary to conduct research to find out, so that data on heavy metal residues in water bodies, biota and sediments in the waters of the Negara River can be known. This is useful as information for policy makers to carry out future management and policies of the Negara River to become an environmentally friendly area, both for fishing and aquaculture activities, as well as a source of food that is safe for consumption (food safety).

METHODS OF RESEARCH

This research was conducted in the waters of the Negara River, Hulu Sungai Selatan Regency, South Kalimantan Province. Sampling was carried out three times with an interval of 2 weeks. The sampling location was determined purposively, in three locations, namely the upstream, middle and downstream areas of the waters. Primary data includes parameters of heavy metals in water, biota and sediment.

Sampling of water for the purpose of heavy metal analysis is carried out by inserting a water sample into a sample bottle, then adding HNO₃ as preservative and cooling it in a cold box. Meanwhile, fish samples for heavy metal analysis are carried out by cutting the flesh of the fish and putting it in a plastic bag. After being weighed with a certain weight, then given a formalin solution to be preserved and put in a plastic bag and cooled in a cold box. Finally, sediment sampling was carried out using a Ponar grab and put it in a plastic bag and given a sample code.

All samples of heavy metal content will be analyzed using the Atomic Absorption Spectrophotometer (AAS) method, and identified at the Laboratory of Standardization and Industrial Services (BPSJI) Banjarbaru. The parameters of heavy metals in water analyzed were Hg, dissolved Cd, dissolved Fe, total dissolved Cr, dissolved Zn, dissolved Cu and dissolved Pb. Meanwhile, heavy metal parameters in snakehead fish (*Chana striata*) and sediment analyzed were Zn, Cd and Pb. The levels of heavy metals in the water will then be compared with the Government Regulations (GR) of Water Quality Standard No. 2/2021 Class 2. Meanwhile, the levels of heavy metals in fish biota will be compared with the Indonesian National Standard of Fresh Fish No. 2729 of 2013. Finally, the levels of heavy metals in sediments will be compared with ISQG (Interim Sediment Quality Guidelines) Standards.

RESULTS AND DISCUSSION

There were 7 heavy metal parameters measured in this study. For the analysis of heavy metals in fish meat and sediment there were only 3, namely Zn, Cd and Pb. Heavy metal data in water, biota and sediment could be seen in Tables 1, 2 and 3.

The concentration of 7 heavy metal parameters obtained from the analysis results listed in Table 1 and Figure 1 is in the range of <0.00095 for dissolved Pb, and 2.233 for dissolved Fe. This is a very low to high concentration range exceeding the water quality standards required by Government Regulation No. 22/2021 Class 2.

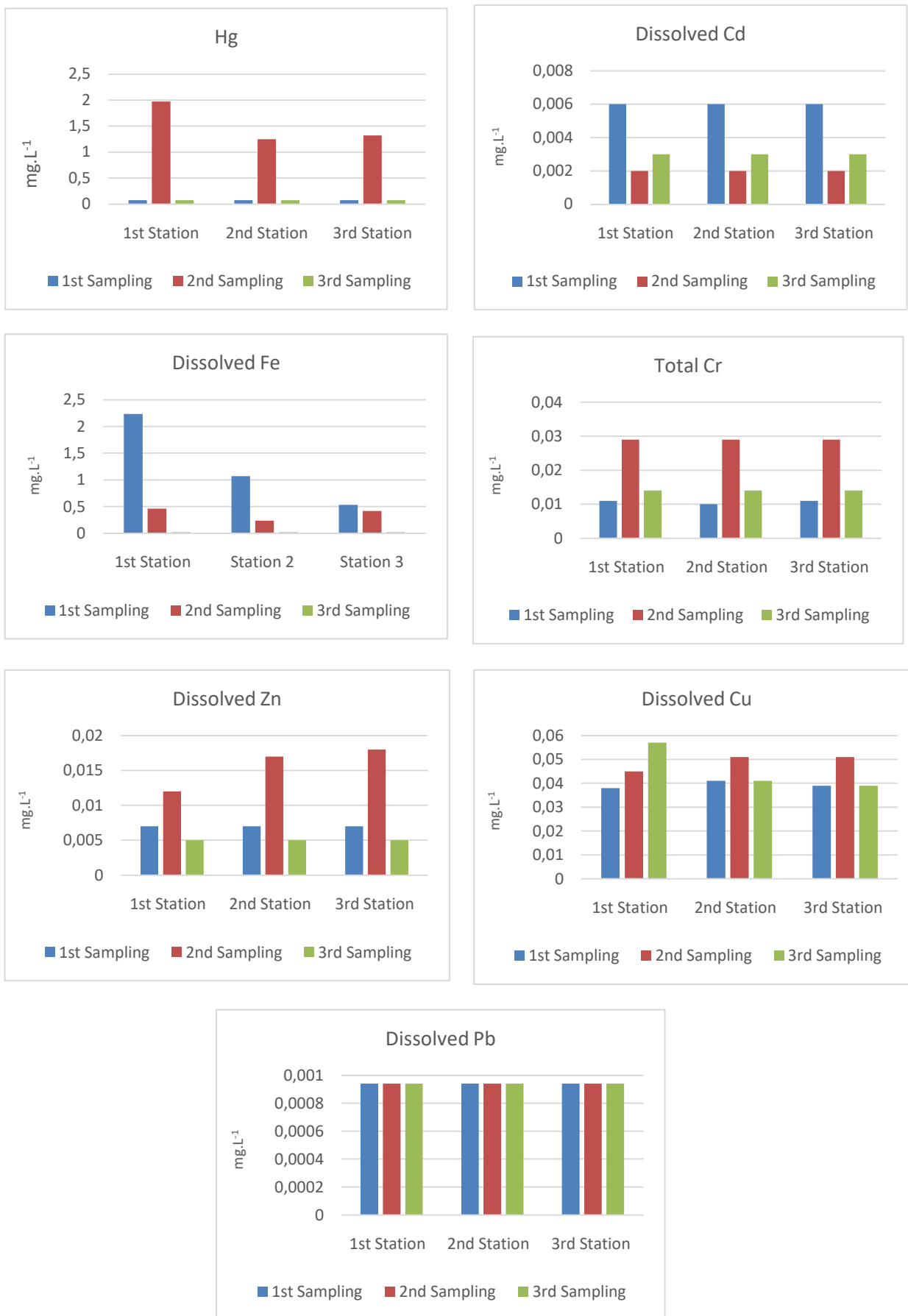


Figure 1 – Concentration of 7 heavy metal parameters in water at each observation station



Table 1 – Data on Insitu Water Quality and Heavy Metals of Negara River

NoParameters	Unit	1st Sampling			2nd Sampling			3th Sampling			GR No 22/2021 (Class 2)
		Station I	Station II	Station III	Station I	Station II	Station III	Station I	Station II	Station III	
1 Hg	mg.L ⁻¹	< 0.075	< 0.075	< 0.075	1,972*	1,249*	1,321*	< 0.075	< 0.075	< 0.075	0.002
2 Dissolved Cd	mg.L ⁻¹	0.006	0.006	0.006	< 0.003	< 0.003	< 0.003	< 0.004	< 0.004	< 0.004	0.01
3 Dissolved Fe	mg.L ⁻¹	2.233*	1.071*	0.533*	0.46*	0.238	0.418*	< 0.020	< 0.020	< 0.020	0.3
4 Total of Dissolved Cr	mg.L ⁻¹	0.011	0.01	0.011	< 0.030	< 0.030	< 0.030	< 0.015	< 0.015	< 0.015	0.05
5 Dissolved Zn	mg.L ⁻¹	< 0.008	< 0.008	< 0.008	0.012	0.017	0.018	< 0.006	< 0.006	< 0.006	0.05
6 Dissolved Cu	mg.L ⁻¹	0.038*	0.041*	0.039*	0.045*	0.051*	0.051*	0.057*	0.041*	0.039*	0.02
7 Dissolved Pb	mg.L ⁻¹	< 0.00095	< 0.00095	< 0.00095	< 0.00095	< 0.00095	< 0.00095	< 0.00095	< 0.00095	< 0.00095	0.03

Note: * = Does Not Meet the Required of Water Quality Standards.

The Hg and Zn levels in sampling 2 were higher than sampling 1 and 3. This is closely related to the different weather conditions at the time of sampling 1 and sampling 2 and 3. At the time of sampling 1, the weather was quite heavy raining, while at the time of sampling 2 and 3, the sun is shining quite hot. Rain causes stirring in the waters so that the heavy metals Hg and Zn spread evenly in the water. Meanwhile, in quite hot weather, stirring depends on the flow of river water and causes heavy metal levels to be suspended in water bodies.

Sudarningsih et al., (2013) states that copper (Cu) is one of the essential metals needed by living things. The increasing activities and demands for human welfare will have an impact on increasing pollution of various heavy metals, including Cu. Contributing sources of heavy metal Cu pollution can come from excessive use of pesticides. This opinion is closely related to the sampling location, where community activities that produce domestic waste cause high levels of Cu in the waters.

Cd metal contamination can be said to be relatively low, even though the threshold value set by WHO and KLH is 0 mg.L⁻¹ (Agus et al., 2020). Cd is toxic and harmful to all living organisms, including humans. The solubility of Cd in a concentration of 1 ppm can kill aquatic biota (Tarigan et al., 2003).

The data obtained shows that the heavy metal content of Cr in the waters at sampling 2 and 3 is very low, which is below the AAS detection limit which only has an accuracy standard of up to 0.030 mg.L⁻¹, so that the heavy metal content of Cr that is read on the monitor is <0.030 mg/L⁻¹. The low levels of Cr in the waters of Sungai Negara in sampling 2 and 3 are due to the dynamic movement of river water.

Analysis of Fe content in the waters was carried out, because the waters contain many ligands that can cause heavy metals to combine (Harteman et al., 2008). The high level of Fe in the waters of Sungai Negara is due to the activity of blacksmith craftsmen along the Sungai Negara. Waste from activities released into rivers can affect the composition of river water. The waste causes the Fe content to be high.

The very low concentration of Pb in the waters of Sungai Negara indicates that the waters were still in a safe condition. Meanwhile, the results of Soeprbowati's research, et al., (2005), showed the presence of heavy metal content of Pb, Cd, Cr and Cu in sediments in Lake Rawapening which had exceeded the maximum threshold (Hidayah, et al., 2012)

Table 2 – Heavy Metal Data on Fish in Negara River

No Parameters	Unit	1 st Sampling			2 nd Sampling			3 th Sampling			SNI
		Station I	Station II	Station III	Stasiun I	Stasiun II	Stasiun III	Station I	Station II	Station III	
1 Zn	mg.Kg ⁻¹	16.709	8.722	7.522	3.261	4.651	1.815	1.622	4.619	1.459	100
2 Cd	mg.Kg ⁻¹	1.145*	1.115*	1.086*	1.154*	0.888*	0.96*	< 0.001	< 0.001	< 0.001	0.1
3 Pb	mg.Kg ⁻¹	0.02	< 0.001	< 0.001	0.458*	0.296	0.162	< 0.001	< 0.001	< 0.001	0.3

Note: * = Does Not Meet the Required of Indonesian National Standard for Fresh Fishes Number 2729/2013.

The levels of zinc (Zn) found in snakehead fish meat (*Chana striata*) caught in the waters of the State River during the observation are known to still meet the quality standards required by the SNI Standard for Fresh Fish number 2729 of 2013 which is 100 mg.Kg⁻¹. The Zn content in snakehead fish in this study as well as blood clams in Kendari Bay and baung fish in the Barito River in this study were still below the quality standard limit, while the Zn



content in lokan in the Dumai river estuary had exceeded the quality standard limit for consumption biota (Amriani, 2010). 2011; Dwiyoitno, et al., 2008; Anggraini, 2007).

The value of cadmium metal (Cd) found in snakehead fish meat (*Chana striata*) caught in the waters of the State River during the observation is known to have exceeded the quality standard required by the SNI Standard for Fresh Fish number 2729/2013 which is 0.1 mg.Kg⁻¹. The high levels of Cd in snakehead fish meat (*Chana striata*) are caused by community activities around the Sungai Negara area. Waste from activities released into rivers can affect the composition of river water. This waste causes high levels of Cd in the water. The high content of Cd in aquatic biota which is then consumed by humans through the concept of the food web can lead to impaired kidney and lung function, increase blood pressure, and lead to infertility in adult men. This is because Cd is cumulative and highly toxic and has the potential to pose a risk to human health (Edogbo et al., 2020; Hidayah, et al., 2012).

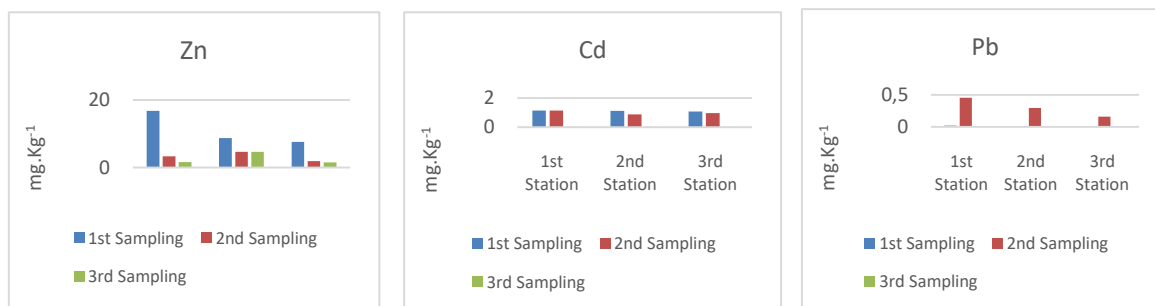


Figure 2 – Concentration of 3 heavy metal parameters in snakehead fish (*Chana striata*) at each observation station

Pb levels in sampling 2 were higher than Pb levels in sampling 1, especially at station 1, where the value had exceeded the required quality standard. This is closely related to the different weather conditions at the time of sampling 1 and sampling 2. At the time of sampling 1, the weather was raining quite heavily, while at the time of sampling 2, the sun was shining quite brightly. According to Wahyuni et al., (2013), the heavy metal content of Pb with a low concentration is caused by most of the Pb metal ions being absorbed by suspended solids as well as plankton. In addition, the concentration of several heavy metals, including Pb in the lotic ecosystem is relatively lower than the lentic ecosystem, due to the presence of water currents in the lotic waters.

Table 3 – Heavy Metal Data on Sediment in Sungai Negara

No Parameters	Unit	1 st Sampling		2 nd Sampling			3 rd Sampling			ISQG	
		Station I	Station II	Stasiun III	Stasiun I	Stasiun II	Stasiun III	Station I	Station II		Station III
		1 Zn	mg.Kg ⁻¹	87.86	226.448*	209.592*	65.395	275.322*	265.72*		76.650
2 Cd	mg.Kg ⁻¹	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.250	< 0.001	0.7
3 Pb	mg.Kg ⁻¹	20.652	33.34*	23.589	14.456	49.014*	19.27	13.283	75.642*	17.069	30.2

Note: * = Does Not Meet the Required of ISQG Standard (Interim Sediment Quality Guidelines).

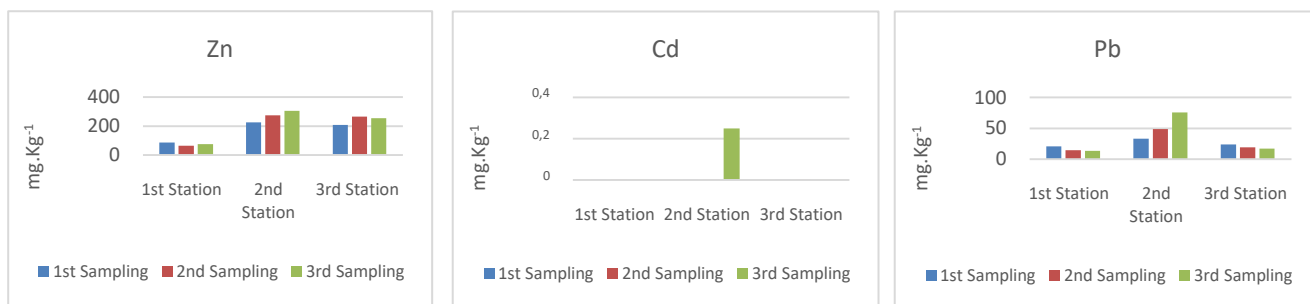


Figure 3 – Concentration of 3 heavy metal parameters in sediment at each observation station



The levels of zinc (Zn) found in the sediments of the Sungai Negara during the observation are known to have exceeded the quality standards required by the ISQG Standard (Interim Sediment Quality Guidelines) for stations 2 and 3. The high levels of Zn at stations 2 and 3 in 3 sampling times were due to by community activities in the area. Domestic household and market waste as well as waste from blacksmith craftsmen contributed to the spread of high levels of Zn which was sedimented in the waters.

Susanti et al., (2014) stated that industrial waste using Zn and domestic waste along the river are the biggest contributors to Zn heavy metal pollution. Preliminary studies on the presence of heavy metals in sediments, including Zn, due to human activities in several locations and outside Indonesia, have been carried out by several previous researchers (Sudarningsih, 2020; Aloupi, & Angelidis, 2014).

Alengebawy et al., (2021) stated that Cd is one of the most common heavy metals found in river waters. In general, Cd concentrations in sediments are below the threshold, even undetected, but in a long time there will be accumulation of Cd in the waters, and therefore the concentration will continue to increase in sediments (Rahman et al., 2019).

Pb levels at station 2 were higher than Pb levels at stations 1 and 3, where the value had exceeded the required quality standard. This is closely related to community activities in residential areas and markets. According to Sofarini et al., (2010), the contamination of sediments by heavy metals, one of which is Pb, is due to the fact that these waters are a reservoir for waste materials from the mainland, both from industrial activities and from household waste disposal.

The accumulation of heavy metals both in the body of biota that live and forage in waters, and especially around aquatic sediments is very dangerous for the life of biota to humans who consume them (food web concept) (Wang et al., 2010; Komari, N et al. , 2013).

CONCLUSION

The results showed that the heavy metal content in the water at sampling 1 to 3 that did not meet the required quality standards were dissolved Fe, dissolved Cu and Hg. The content of heavy metals that exceed SNI standards in fish are Cd and Pb, and in sediments are Zn and Pb.

The existence of community activities and blacksmiths causes high levels of dissolved Hg and Fe in water, high levels of Cu in water and Zn and Pb in sediments due to oil palm plantation activities in upstream waters. Meanwhile, the high levels of Cd and Pb in fish meat have become an early warning for the products of food safety, sourced from the waters of the Negara River.

ACKNOWLEDGEMENTS

Acknowledgments are conveyed to the Institute for Research and Community Service at Lambung Mangkurat University (LPPM ULM) through the Compulsory Research Lecturer Program Scheme (PDWM) of DIPA Lambung Mangkurat University Fiscal Year 2022 Number: SP DIPA – 023.17.2.677518/2022 dated 17 November 2021 Lambung Mangkurat University Ministry of Education, Culture, Research and Technology In accordance with the Decree of the Chancellor of Lambung Mangkurat University Number: 458/UN8/PG/2022 dated March 28, 2022, which has funded this research.

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