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Analysis of Lead (Pb) Metal Content in Catfish Meat (*Clarias batrachus* L) Sold at Bekonang Market, Sukoharjo

Makhabbah Jamilatun[1*], Wiwit Widitya Agustin[2], Ronald Tolkhah[3]
Department of Pharmaceutical and Food Analysis, Health Polytechnic of Health Ministry Surakarta
Corresponding Author: Makhabbah Jamilatun makhabbah.j@gmail.com

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A B S T R A C T

Catfish (*Clarias bathracus* L) can survive and be able to tolerate polluted water conditions. Lead metal naturally occurs in water and contaminates the organisms in it. Lead metal contamination in fish will cause poisoning and brain damage if it enters the human body's metabolism and accumulates in amounts that exceed the threshold. This research was conducted to determine the content of Pb metal in catfish meat sold at Bekonang Market, Sukoharjo. The method used in this research is a qualitative analysis using the K2CrO4 reagent and a quantitative analysis using Atomic Absorption Spectrophotometry. The results of the research with K2CrO4 reagent showed that samples A, B, C, D, and E were negative respectively. The average levels of lead (Pb) in catfish meat samples A, B, C, D, and E were -21.98 mg/Kg ± 0.140; -22.10 mg/Kg ± 0.035; -24.32 mg/Kg ± 0.107; -10.99 mg/Kg ± 0.191; and -24.36 mg/Kg ± 0.091. Based on the results of the study, it can be concluded that the content is still below the threshold according to the requirements for lead (Pb) levels allowed by Republic of Indonesia Food and Drug Supervisory Agency Regulation Number 5 of 2018 concerning the Maximum Limit of Heavy Metal Contamination of 20 mg/kg.

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INTRODUCTION

Rapid industrial development affects the environment, especially the occurrence of air, land, and water pollution. Water pollution occurs in various sectors, including the fisheries sector. Various types of fish that grow in waters, both on beaches and in freshwater ponds located in residential areas, have the potential to be contaminated due to the condition of the water which has become polluted. Pollution can be caused by a series of irrigation processes which usually pass through rice fields, waste from industry, and waste originating from households (Khairuddin & Yamin, 2021). So this situation does not guarantee that the condition of the water used for growth in freshwater fish habitat, even though its position is far from industrial areas, can be safe from pollution (Zulfiah et al., 2017). Pollution by heavy metals can occur in the aquatic environment which will later affect water quality. One type of waste that has the potential to become a pollutant in water is heavy metals.

Heavy metals are dangerous for the body because heavy metals can accumulate in the cells or tissues that make up the bodies of aquatic organisms. This situation can occur either directly or through the food chain when fish consume plankton, either phyto or zooplankton that has been contaminated by metal (Arkianti et al., 2019). Accumulation of heavy metals can also occur in fish bodies through sediment and the remains of dead living creatures that settle at the bottom of the water (Azizah & Maslahat, 2021), (Adhani & Husaini, 2017). The amount of heavy metals in fish varies from part to part. The highest concentration of heavy metals accumulated in the fish's body is contained in the liver, bones, and head (Yulaipi & Aunurohim, 2013). The smallest concentration is contained in the skin and flesh of fish, but this is the part that is often consumed by the public (Hardinawati, 2017).

Lead (Pb) is known as one of the heavy metals that is naturally found in the aquatic environment. This metal is used in making batteries, pipes, and other industrial products (Adhani & Husaini, 2017). The presence of this metal can occur through the process of damage to mineral rocks caused by waves or wind, and it can also enter the waters through the process of crystallizing Pb metal from the air with the help of rainwater (Yulianto & Amaloyah, 2017). The heavy metal lead (Pb) can also come from water pipes which are known to contain layers of heavy metals (Yulianto & Amaloyah, 2017); (Adhani & Husaini, 2017), apart from that it can also be obtained from pollutants produced by domestic household waste, even in quite high quantities, which causes Lead (Pb) pollution in waters (Adhani & Husaini, 2017), (Istiqomah & Jamilatun, 2023). Lead metal (Pb) is non-biodegradable and can accumulate in living organisms (Subarkhah & Titah, 2023). The heavy metal lead (Pb), has a route of entry into the bodies of organisms living in waters through three ways, namely consumption of contaminated food, inhalation, and diffusion that occurs through the surface of the skin (Haryanti & Martuti, 2020). If food containing high amounts of the heavy metal lead (Pb) enters the human body, it can cause blood synthesis disorders, hypertension, and brain damage (Ardillah, 2016), besides that it can cause nausea, damage to the central nervous system, headaches, and reduces intelligence (Adhani & Husaini, 2017). The maximum

limit for lead (Pb) heavy metal contamination in fish and fishery products is 20 mg/kg, by Republic of Indonesia Food and Drug Supervisory Agency Regulation Number 5 of 2018 concerning Maximum Limits for Heavy Metal Contamination (BPOM, 2018).

Based on previous research, Lead (Pb) metal contamination has been found in fish in the fishing village area of the Panjang sub-district, namely Rastrelliger kanagurta fish, where lead metal has exceeded the predetermined threshold (Priatna et al., 2016). Pb metal was also found in canned fish circulating in Gorontalo City (Purnama et al., 2018). Research conducted by Priatna et. al. shows that lead metal (Pb) has been found in bader fish (Priatna et al., 2016). The discovery of heavy metals in the cells or tissues that make up an organism's body is an indicator that there is a source of heavy metals in the organism's environment (Fadlilah et al., 2023). Thus, fish or other aquatic organisms can be used as indicators of heavy metal pollution. If a fish's body contains high levels of heavy metals, even exceeding the specified requirements, then these heavy metals become poisons that damage the bodies of living creatures. Meanwhile, until now, heavy metals such as lead or lead can be found in water bodies where aquatic organisms live (Wanna et al., 2018).

One of the fish that lives in freshwater is catfish. Many people like and eat catfish (*Clarias bathracus* L). Catfish are known to have high protein and nutritional content, besides that they are affordable and relatively cheap (Anwar et al., 2021), and can live in water conditions that contain little oxygen (Rosmawati & Muarif, 2010). Mudfish, the term used to refer to catfish (*Clarias bathracus* L), is that catfish can survive and can tolerate polluted water conditions (Yaqin, 2019), and can survive in extreme conditions. The presence of lead in an environment is the result of human activities. These activities can take the form of mining, industrial activities with metal products such as manufacturing, burning fossils, cosmetics, as well as battery and pipe production (Adhani & Husaini, 2017). There are health risks that occur due to food containing lead. From this description, research was carried out on the levels of Lead (Pb) metal contamination in catfish meat (*Clarias bathracus* L) sold at Bekonang Market, Sukoharjo.

THEORETICAL FRAMEWORK

This metal is used in making batteries, pipes, and other industrial products (Adhani & Husaini, 2017). The presence of this metal can occur through the process of damage to mineral rocks caused by waves or wind, and it can also enter the waters through the process of crystallizing Pb metal from the air with the help of rainwater (Yulianto & Amaloyah, 2017). The heavy metal lead (Pb) can also come from water pipes which are known to contain layers of heavy metals (Yulianto & Amaloyah, 2017); (Adhani & Husaini, 2017), apart from that it can also be obtained from pollutants produced by domestic household waste, even in quite high quantities, which causes Lead (Pb) pollution in waters (Adhani & Husaini, 2017), (Istiqomah & Jamilatun, 2023). Lead metal (Pb) is non-biodegradable and can accumulate in living organisms (Subarkhah & Titah, 2023). The heavy metal lead (Pb), has a route of entry into

the bodies of organisms living in waters through three ways, namely consumption of contaminated food, inhalation, and diffusion that occurs through the surface of the skin (Haryanti & Martuti, 2020). If food containing high amounts of the heavy metal lead (Pb) enters the human body, it can cause blood synthesis disorders, hypertension, and brain damage (Ardillah, 2016), besides that it can cause nausea, damage to the central nervous system, headaches, and reduces intelligence (Adhani & Husaini, 2017). The maximum limit for lead (Pb) heavy metal contamination in fish and fishery products is 20 mg/kg, by Republic of Indonesia Food and Drug Supervisory Agency Regulation Number 5 of 2018 concerning Maximum Limits for Heavy Metal Contamination (BPOM, 2018).

METHODOLOGY

This type of research is quantitative descriptive research. This research explains the metal lead (Pb) content in catfish meat sold at Bekonang Sukoharjo Market, expressed qualitative analysis using the K2CrO4 reagent and a quantitative analysis using Atomic Absorption Spectrophotometry. The materials used in the research included fresh meat from 5 catfish from 5 traders, K2CrO4 5%, Pb(NO3)2, Aquadest, HNO3 p.a 65%, HCl: HNO3, Mg(NO3)2, Ethanol 95%. The tools used include an Atomic Absorption Spectrophotometer, volume pipette, digital balance, hot plate, beaker glass, porcelain cup, porcelain crucible, measuring flask, stir bar, dropper pipette, muffle furnace, mortar and stamper, measuring cup, filter paper. Whatman 540, watch glass.

The research procedure includes several stages. 1). Sample preparation ([BSN] Badan Standardisasi Nasional, 1998). 2 grams of catfish meat was placed in a porcelain cup and 10 ml of magnesium nitrate solution in ethanol was added, and stirred until homogeneous. The ethanol was evaporated in a water bath with occasional stirring and then heated in an electric bath (covered with a watch glass). The glass cup is moved into a kiln at a temperature of 200°C and increases the temperature to 500°C over 2 hours gradually, then ashed overnight at a temperature of 450°C-500°C. The glass cup is removed from the furnace and left to cool on asbestos. If carbon residue is found, add 1 ml of water and 2 ml of HNO3. After it cools, then dry it. Then, heated again at 500°C for 1 hour. Repeat this treatment until white ash is obtained. Then 5 ml of a mixed solution of HCl and HNO3 was added to the ash which was carried out through the wall of the glass cup. Then heat until the ash dissolves. The solution was quantitatively transferred into a 100 ml volumetric flask, then distilled water was added and filtered using Whatman 540 paper. 2). Lead Qualitative Analysis. The sample that has been destroyed is taken sufficiently and then added with 10 drops of K2CrO4 solution. A positive result for the presence of lead metal (Pb) is indicated by the formation of a yellow precipitate (Refilda et al., 2020) 3). Determination of Lead Levels refers to ([BSN] Badan Standardisasi Nasional, 1998), (Istiqomah & Jamilatun, 2023); (Yaqin, 2019). a). Preparation of 1000 ppm Pb(NO3)2 Main Solution. This solution was made by weighing 0.1598 g of Pb(NO3)2 into a 100 ml measuring flask, adding 2 ml of distilled water, stirring until homogeneous if necessary by heating, then adding distilled water to the mark. b). Preparation of 10 ppm Pb(NO3)2 Standard

Solution. Making a 100 ppm Pb solution by diluting it with a standard 1000 ppm Pb solution. 10.0 mL of a standard solution of 1000 ppm was taken and put into a 100 mL measuring flask with distilled water added up to the mark. c). Preparation of a Series of Lead Standard Solutions. A series of standard solutions was prepared with concentrations in ppm 0; 2; 4; 8; 12; 16 and 20 by pipetting a 100 ppm Pb standard solution as much as 0; 1.0; 2.0; 4.0; 6.0; 8.0 and 10.0 mL into a 50 mL measuring flask then add distilled water to the mark. d). Quantitative Analysis of Lead Metal Content. The absorbance of the 100 ml digestion sample solution was measured using AAS at an absorption wavelength of 283.3 nm. The results of the absorption readings are entered into the linear regression equation.

RESULTS

The results of analysis of lead metal (Pb) in catfish meat samples (*Clarias bathracus* L) are shown in Table 1 and Table 2.

Table 1. Lead Tube Test Results (Pb) on Catfish Meat (*Clarias bathracus* L)

Sample	Test results	Interpretation
Positive Control	yellow precipitate	(+) positive
Sample A	no yellow precipitate	(-) negative
Sample B	no yellow precipitate	(-) negative
Sample C	no yellow precipitate	(-) negative
Sample D	no yellow precipitate	(-) negative
Sample E	no yellow precipitate	(-) negative

Description: Sample A (catfish from the 1st trader); Sample B (catfish from 2nd trader); Sample C (catfish from 3rd trader); Sample D (catfish from the 4th trader); Sample E (catfish from 5th trader).

Table 2. Results of Lead Metal Levels (Pb) in Catfish Meat (*Clarias bathracus* L)

Sample	Average Absorbance	Average levels (mg/kg) ± SD	Information
Sample A	0,00253	-21,98 ± 0,140	Meets the requirements of Food and Drug Supervisory Agency regulations, Number 5 of 2018 concerning the Maximum Limit for Heavy Metal Contamination of 20 mg/kg.
Sample B	0,00244	-22,10 ± 0,035	
Sample C	0,00078	-24,32 ± 0,107	
Sample D	0,01078	-10,99 ± 0,191	
Sample E	0,00042	-24,36 ± 0,091	

Description: Sample A (catfish from the 1st trader); Sample B (catfish from 2nd trader); Sample C (catfish from 3rd trader); Sample D (catfish from the 4th trader); Sample E (catfish from 5th trader).

DISCUSSION

Analysis of lead metal content in catfish meat (*Clarias bathracus* L) sold at Bekonang Sukoharjo Market was carried out to determine whether or not there was lead metal (Pb) content in catfish meat (*Clarias bathracus* L). The catfish (*Clarias bathracus* L) used as samples in this study were 5 catfish from 5 different traders selling at Bekonang Market, Sukoharjo. Catfish samples are marked with a code, sample A from the 1st trader, sample B from the 2nd trader, sample C from the 3rd trader, sample D from the 4th trader, and sample E from the 5th trader. Two grams of each sample was taken from the flesh of the catfish, then destroyed by dry ashing, then analyzed for lead (Pb) levels qualitatively using a tube test with K2CrO4 reagent and quantitatively using an Atomic Absorption Spectrophotometer.

Based on the results of qualitative analysis of lead metal (Pb) in catfish meat samples (Table 1.), it was found that there was no heavy metal lead (Pb) content. This is indicated by the absence of yellow precipitate formation when the K2CrO4 reagent is added. These results are different from the qualitative analysis of the positive control Pb solution, which showed the formation of a yellow precipitate when the K2CrO4 reagent was added. The results of the qualitative analysis of lead metal (Pb) in catfish meat were negative, which occurred due to the small concentration of lead contained in catfish meat (*Clarias bathracus* L) so there was no visible change in the addition of reagents. Next, a test for the heavy metal lead (Pb) was carried out using an Atomic Absorption Spectrophotometer to obtain the exact level of the heavy metal lead (Pb) in the catfish meat samples (Table 2.).

Analysis of lead (Pb) metal levels in catfish meat was carried out using an Atomic Absorption Spectrophotometer. In the preparation stage of the catfish meat sample, HNO3 is added as a strong oxidizer which functions to decompose the organic matrix in the sample so that it is easy to oxidize and dissolve the lead metal which is reduced in the ashing process at a temperature of 500°C until white ash is obtained (Hidayat, 2013). Based on Table 2, the average Pb content of 5 catfish meat samples was obtained, namely Sample A - 21.98 ± 0.140, sample B -22.10 ± 0.035, sample C -24.32 ± 0.107, sample D -10.99 ± 0.191 and sample E -24.36 ± 0.091. From these results, it is known that the Pb levels obtained from 5 samples of catfish meat (*Clarias bathracus* L) sold at the Bekonang Sukoharjo Market, each met the quality requirements by Republic of Indonesia Food and Drug Supervisory Agency Regulation Number 5 of 2018 concerning the Maximum Limit for Heavy Metal Contamination of 20 mg/kg (BPOM, 2018).

The content of the heavy metal lead (Pb) in catfish (*Clarias bathracus* L) meat is relatively low because the meat is tissue that does not experience direct contact with sources of heavy metal pollution in the water. The small levels of lead (Pb) in catfish meat are in line with the results of Fadhlan's research,

milkfish meat has the smallest concentration of lead (Pb) because the level of absorption of heavy metals in the digestive tract tends to be small (Fadhlan, 2016). This research is strengthened by Nurachmi's statement, that the low concentration of heavy metals in meat is related to the physiological role in metabolism where meat is not tissue that is active in accumulating heavy metals compared to other organs whose regulatory abilities and functions are more active with metals in water (Amin Irvina; Habibi, Muhammad Nudi, 2011). The low lead (Pb) content in catfish (Clarias bathracus L) meat can also be due to the location of catfish sales at Bekonang Sukoharjo Market, where the catfish are located market and far from the main road so they are not too exposed to dust and air containing emissions. lead metal (Pb).

The results of this research show that all catfish samples sold at the Bekonang Sukoharjo Market contain very small amounts of heavy metal lead (Pb) so they are safe for public consumption. The results of this research are in line with Diana's research, the metal Pb is concentrated in cendro fish (*Tylosurus crocodilus*) in the gills (Diana, Rinidar, 2017) as well as Nur's research, the content of the heavy metal lead (Pb) in tilapia (*Oreochormis niloticus* Linn), each of which is suitable for consumption (Nur & Hasyim, 2020). Even though it is safe to consume, you must still pay attention to the amount of intake each day. The presence or absence of heavy metal residues must be monitored because heavy metals can accumulate in organisms over time (Fadlilah et al., 2023). Sources of heavy metal contamination come from food and aquatic environments that are contaminated with heavy metals. Bioaccumulation of lead from fish to humans occurs through the process of polluted water conditions, contaminating fish. Furthermore, cross-contamination occurs during the process of packaging and transporting fish from fish farms to restaurants. Besides that. sanitation hygiene during the fish processing process (Fadlilah et al., 2023).

Food and drinks that are exposed to lead compounds will enter the human body and can affect metabolism in the body. Lead enters the body through the digestive tract, then is distributed in red blood cells, and the remainder is bound to plasma (Rosita et al., 2018). Red blood cells contain erythrocytes which bind oxygen in the blood. Erythrocytes can survive a relatively short life if there is a disorder caused by poisoning due to lead metal contamination, which causes hemolytic anemia (Wiratama et al., 2018). In addition, the accumulation of lead (Pb) in the human body can disrupt mitochondrial function. Lead metal can also cause DNA repair to fail and cause damage to double-stranded DNA. Exposure to lead also causes RNA hydrolysis which then gives rise to free radicals resulting in lipid oxidation and can cause damage to cells. The process of excretion of lead (Pb) in the body is very slow, causing heavy metals (Pb) to accumulate very easily in the body (Rosita et al., 2018).

CONCLUSIONS AND RECOMMENDATION

The metal content of lead (Pb) in samples of catfish (Clarias bathracus L) meat measured using an Atomic Absorption Spectrophotometer (SSA) was found to sample A, B, C, D, E respectively -21.98 mg/Kg ± 0.140, -22.10 mg/Kg ± 0.035, -24.32 mg/Kg ± 0.107, -10.99 mg/Kg ± 0.191 and -24.36 mg/Kg ± 0.091. This content is still below the threshold according to lead (Pb) content requirements of 20 mg/kg, by Republic of Indonesia Food and Drug Supervisory Agency Regulation Number 5 of 2018 concerning Maximum Limits for Heavy Metal Contamination.

REFERENCES

Adhani, R., & Husaini. (2017). *Logam Berat Sekitar Manusia*. Lambung Mangkurat University Press.

Amin Irvina; Habibi, Muhammad Nudi, B. N. (2011). Bioakumulasi Logam Cd, Cu, Pb dan Zn Pada Beberapa Bagian Tubuh Ikan Gulama (*Sciaena ruselli*) dari Perairan Dumai, Riau. *Maspari Journal*, *02*(Vol 2, No 1 (2011): Edisi Januari), 1–10. http://ejournal.unsri.ac.id/index.php/maspari/article/view/1117

Anwar, R., Wibowo, T. A., & Untari, D. S. (2021). Tingkat Penerimaan Masyarakat di Kecamatan Kotabumi Selatan Terhadap Ikan Lele (Clarias sp) dengan Metode Pembesaran yang Berbeda: Level of Public …. *Open Science and Technology*, *01*(01), 114–120. https://opscitech.com/journal/article/view/13%0Ahttps://opscitech.com/journal/article/download/13/16

Ardillah, Y. (2016). Risk Factors of Blood Lead Level. *Jurnal Ilmu Kesehatan Masyarakat*, *7*(3), 150–155. https://doi.org/10.26553/jikm.2016.7.3.150-155

Arkianti, N., Dewi, N. K., & Tri Martuti, N. K. (2019). Kandungan Logam Berat Timbal (Pb) pada Ikan di Sungai Lamat Kabupaten Magelang. *Life Science*, *8*(1), 65–74. https://doi.org/10.15294/lifesci.v8i1.29991

Azizah, M., & Maslahat, M. (2021). Kandungan Logam Berat Timbal (Pb), Kadmium (Cd), dan Merkuri (Hg) di dalam Tubuh Ikan Wader (Barbodes binotatus) dan Air Sungai Cikaniki, Kabupaten Bogor. *Limnotek : Perairan Darat Tropis Di Indonesia*, *28*(2), 83–93. https://doi.org/10.14203/limnotek.v28i2.331

Badan Standardisasi Nasional. (1998). *Cara uji cemaran logam dalam makanan (SNI 19-2896-1998)*. Badan Standardisasi Nasional.

BPOM, B. P. O. dan M. (2018). *Peraturan Badan Pengawas Obat dan Makanan Nomor 7 Tahun 2018 tentang Bahan Baku yang dilarang dalam Pangan Olahan*.

Diana, Rinidar, T. A. T. (2017). *Cemaran Logam Berat Timbal (Pb) pada Insang Ikan Cendro (Tylosurus crocodilus) di Pesisir Krueng Raya Kabupaten Aceh Besar*. *01*(3), 258–264.

Fadhlan, A. (2016). *Analisis Kandungan Logam Berat Timbal (Pb) Pada Ikan Bandeng (Chanos-chanos) di Beberapa Pasar Tradisional Kota Makassar*.

Fadlilah, I., Triwuri, N. A., & Prasadi, O. (2023). Biokonsentrasi Faktor Logam

Berat Timbal (Pb) pada Ikan di Pantai Kemiren Cilacap , Jawa tengah. *Jurnal Teknologi Lingkungan Lahan Basah*, *11*(1), 94–99. https://ejournal.upbatam.ac.id/index.php/rsi/article/view/213

Hardinawati. (2017). Analisis Kandungan Logam Berat Timbal (Pb) PADA Hati , Daging Dan Kulit Ikan Baronang Di Pulau Lae Lae. *Skripsi Universitas Islam Negeri Alauddin Makassar*.

Haryanti, E. T., & Martuti, N. K. T. (2020). Analisis Cemaran Logam Berat Timbal (Pb) dan Kadmium (Cd) Dalam Daging Ikan Kakap Merah (Lutjanus sp.) Di TPI Kluwut Brebes. *Life Science*, *9*(2), 149–160. http://journal.unnes.ac.id/sju/index.php/LifeSci

Istiqomah, R., & Jamilatun, M. (2023). *Analisis Kadar Timbal (Pb) pada Kerupuk Yang Diproduksi Industri Rumahan Di Kecamatan Gatak Kabupaten Sukoharjo*. *10*(1), 17–30. https://jurnal.poltekkesbanten.ac.id/Medikes/article/view/361

Khairuddin, K., & Yamin, M. (2021). Analysis of Cadmium (Cd) and Lead (Pb) Heavy Metal Content in Shell and Mangroves at Bima Bay. *Journal of Science and Science Education*, *2*(1). https://doi.org/10.29303/jossed.v2i1.726

Nur, S.-, & Hasyim, A. (2020). Analisis Kandungan Logam Berat Plumbum (pb) pada Ikan Nila (Oreochormis niloticus Linn) di Danau Tunggu Pampang Makassar. *Science Education and Application Journal*, *2*(1), 22. https://doi.org/10.30736/seaj.v2i1.180

Priatna, D. E., Purnomo, T., & Kuswanti, N. (2016). Kadar Logam Berat Timbal (Pb) pada Air dan Ikan Bader (Barbonymus gonionotus) di Sungai Brantas Wilayah Mojokerto The Content of Heavy Metal Lead (Pb) in the Water and Bader Fish (Barbonymus gonionotus) of Brantas River , Mojokerto Region. *Lentera Bio*, *5*(1), 48–53.

Purnama, R. C., Agustina Retnaningsih, & Andriyan, A. (2018). *Penetapan Kadar Logam Timbal (Pb) pada Ikan (Rastrelliger kanagurta) di Daerah Kampung Nelayan Kecamatan Panjang dengan Spektrofotometri Serapan Atom (SSA)*. *3*(4), 259–265.

Refilda, Aliju, S. Z., & Indrawati. (2020). Pengaruh Lama Penyimpanan Ikan Sardeb Kemasan Kaleng terhadap Kadar Pb dan Cu. *Chempublish Journal*, *5*(2).

Rosita, B., Program, L., Analis, S., Stikes, K., & Padang, P. (2018). Hubungan Toksisitas Timbal (Pb) Dalam Darah Dengan Hemogoblin Pekerja Pengecatan Motor Pekanbaru. *Prosiding Seminar Kesehatan Perintis E*, *1*(1), 2622–2256.

Rosmawati, & Muarif. (2010). Kelangsungan Hidup Dan Pertumbuhan Benih Ikan Lele Dumbo (Clarias Sp.) Pada Sistem Resirkulasi Dengan Kepadatan Berbeda. *Sains Akuatik*, *13*(2), 1–8.

Subarkhah, M. J., & Titah, H. S. (2023). *Remediasi Logam Berat Pb dengan Menggunakan*. *12*(1), 1–6.

Wanna, M., Yanto, S., & Kadirman, K. (2018). Analisis Kualitas Air Dan Cemaran Logam Berat Merkuri (Hg) dan Timbal (Pb) pada Ikan di Kanal Daerah Hertasning Kota Makassar. *Jurnal Pendidikan Teknologi Pertanian*, *3*. https://doi.org/10.26858/jptp.v3i0.5719

Wiratama, S., Sitorus, S., Kartika Jurusan Kimia, R., Matematika dan Ilmu Pengetahuan Alam, F., Mulawarman Jalan Barong Tongkok, U., & Gn Kelua, K. (2018). Studi Bioakumulasi Ion Logam Pb dalam Rambut dan Darah Operator Stasiun Pengisian Bahan Bakar Umum, Jalan Sentosa, Samarinda. *Jurnal Atomik*, *03*(1), 1–8.

Yaqin, K. (2019). Bioakumulasi Paparan Logam Berat Cadmium (Cd) Pada Daging Ikan Lele (Clarias sp.). *Journal of Fosheries and Marine Science*, *3 No*, *2*(Cd), 215–221.

Yulaipi, S., & Aunurohim. (2013). Bioakumulasi Logam Berat Timbal (Pb) dan Hubungannya dengan Laju Pertumbuhan Ikan Mujair (Oreochromis mossambicus). *Jurnal Sains Dan Seni Pomits*, *2*(2).

Yulianto, & Amaloyah, N. (2017). Bahan Ajar Kesehatan Lingkungan Toksikologi Lingkungan. *Pusat Pendidikan Sumber Daya Manusia Kesehatan, Badan Pengembangan Dan Pemberdayaan Sumber Daya Manusia Kesehatansehatan*, *4*(1).

Zulfiah, A., Seniwati, S., & Sukmawati, S. (2017). Analisis Kadar Timbal (Pb), SENG (Zn) dan Tembaga (Cu) pada Ikan Bandeng (*Chanos chanos* Forsk.) yang Berasal dari Labbakkang Kab. Pangkep secara Spektrofotometri Serapan Atom (SSA). *Jurnal Ilmiah As-Syifaa*, *9*(1). https://doi.org/10.33096/ja.v9i1.257