Jurnal Sains dan Teknologi
Volume 12 Number 2, Tahun 2023, pp. 385-395
P-ISSN: 2303-3142 E-ISSN: 2548-8570
Open Access: https://doi.org/10.23887/jstundiksha.v12i2.53714

Analysis of Pollution Levels of Heavy Metals of Lead (Pb) And Copper (Cu) In Freshwater Fish In Lake Toba Water

Eva Pratiwi Pane[1*], Fine Eirene Siahaan[2]

[1,2] Chemistry Education Study Program, Faculty teacher and Knowledge Education, Universitas HKBP Nommensen Pematangsiantar, Pematangsiantar, Indonesia

ARTICLE INFO

Article history:
Received November 03, 2022
Revised November 11, 2022
Accepted May 13, 2023
Available online July 25, 2023

Kata Kunci:
Timbal; Tembaga, danau, Ikan;, Air tawar***Keywords:***

Keywords:
Leads; Copper, Lakes; Fish;, Freshwater

ABSTRAK

Aktivitas masyarakat dalam upaya memanfaatkan kekayaan sumber daya air Danau Toba dapat menghasilkan logam berat di perairan dan mempengaruhi kehidupan biota yang berinteraksi langsung dengan perairan khususnya ikan air tawar. Penelitian ini bertujuan untuk menganalisis konsentrasi logam berat yang terkandung pada ikan air tawar di perairan Danau Toba. Penelitian dilakukan pada bulan Agustus-September 2022 di perairan Danau Toba, Kabupaten Simalungun, Provinsi Sumatera Utara. Proses pengambilan sampel menggunakan metode purposive sampling. Analisis data dilakukan secara deskriptif dengan melihat hasil pengukuran beberapa parameter air dan hasil uji sampel di laboratorium dengan membandingkan baku mutu. Hasil konsentrasi logam berat yang terkandung pada ikan air tawar untuk Pb berkisar antara 0,0386 – 0,0700 ppm sedangkan untuk logam Cu berkisar antara 0,0059 – 0,0325 ppm. Hasil perhitungan nilai faktor biokonsentrasi (BCF) ikan air tawar terhadap logam Pb berkisar antara 0,401 hingga 0,721 sedangkan nilai faktor biokonsentrasi (BCF) logam Cu berkisar antara 2,347 hingga 8,325. Analisis pengaruh hubungan kandungan logam berat pada plankton terhadap parameter lingkungan yang diolah menggunakan software SPSS 16 menunjukkan bahwa terdapat hubungan yang cukup erat antara logam berat Pb dan Cu pada ikan air tawar yang dipengaruhi oleh parameter perairan di Danau Toba. Parameter lingkungan yang mempengaruhi kandungan logam berat pada ikan air tawar antara lain suhu, kecepatan arus, salinitas, oksigen terlarut dan pH.

ABSTRACT

Community activities in an effort to utilize the wealth of Lake Toba water resources can produce heavy metals in the waters and affect the life of biota that interact directly with the waters, especially freshwater fish. This research aims to analyzez the concentration of heavy metals contained in freshwater fish in the waters of Lake Toba. The research was conducted in August-September 2022 in the waters of Lake Toba, Simalungun Regency, North Sumatra Province. The sampling process used purposive sampling method. Data analysis was carried out descriptively by looking at the results of measurements of several water parameters and the results of sample tests in the laboratory by comparing the quality standards. The results of the concentration of heavy metals contained in freshwater fish for Pb ranged from 0.0386 to 0.0700 ppm while for Cu metal ranged from 0.0059 to 0.0325 ppm. The results of the calculation of the value of the bioconcentration factor (BCF) of freshwater fish on Pb metal ranged from 0.401 to 0.721 while the value of the bioconcentration factor (BCF) of Cu metal ranged from 2.347 to 8.325. Analysis of the effect of the relationship between heavy metal content in plankton on environmental parameters processed using SPSS 16 software, showed that there was a fairly close relationship between heavy metals Pb and Cu in freshwater fish which was influenced by water parameters in Lake Toba. Environmental parameters that affect the content of heavy metals in freshwater fish include temperature, current velocity, salinity, dissolved oxygen and pH.

1. INTRODUCTION

Indonesian waters have been polluted by heavy metals hazardous substances such as Mercury (Hg), Arsenic (Ar), Nickel (Ni), Cadmium (Cd), Copper (Cu) and Lead (Pb) both in rivers, lakes and in the sea. The development of technology and the number of activities humans, then this can lead to increased water pollution Lake Toba (Adagunodo et al., 2018; Rahmat et al., 2016). Lake Toba is the largest lake in Indonesia which is formed volcanically-tectonic, located in the Bukit Barisan mountains. The surface area of the lake is ± 1,100 km 2 with a total of water volume ± 1,258 km 3 (Barus et al., 2022; Garno et al., 2020). The deepest waters are around 499 m and are at a maximum height 900 meters. The bottom of the lake consists mostly of rocks, sand and in certain parts there are silt. The process of burning diesel in the engine ships will produce exhaust emissions containing lead and copper. This matter cause water pollution by heavy metals lead (Pb) and copper (Cu) on the coast Lake Toba. The content of lead (Pb) and

*Corresponding author.
E-mail addresses: evapratiwi2607@gmail.com (Eva Pratiwi Pane)

copper (Cu) heavy metals is not yet known in the lake water and freshwater fish in the waters of Lake Toba. This situation can cause disruption or even cause death in various aquatic biota such as freshwater fish found in the waters of Lake Toba which are vulnerable to pollution, especially heavy metals lead (Pb) and copper (Cu) (Kartamihardja et al., 2015; Raja et al., 2023; Susanto et al., 2021). Increased levels of heavy metals in water will result in heavy metals that beginning needed for various process metabolism could changed Becomes poison and cause toxic effects on biota. Consumption of farmed fish that have been polluted will cause humans to be exposed to heavy metals. Lead and copper are heavy metals which the most dangerous which has the most dangerous toxic effect together with lead (Pb) and copper (Cu) (Ahamad et al., 2020; Mansor et al., 2022). If fish containing lead (Pb) and copper (Cu) are consumed by humans and pass the maximum amount of food additives can be consumed every day for life will be bad for health because it can damage the human nervous system, the system of blood formation processes, and can interfere with the reproductive system (Amelia et al., 2019; Oladipo et al., 2020). Especially in children who can spoil its growth. According to WHO and FAO maximum amount of food additives or Acceptable Daily Intake of lead heavy metal can be accepted by humans as much as 25 mg/kg. Results that obtained will be adjusted to the National Standards of the Ministry of Health of the Republic of Indonesia (Anggraini & Puryanti, 2019; Nasution et al., 2016). The purpose of the study was to examine the content of heavy metals lead (Pb) and copper (Cu) which found in freshwater fish in the water Lake Toba. The stages of the method in this study began with sampling carried out by purposive random sampling at four stations representing residential areas. Determination of heavy metal content in freshwater fish using test method AAS (Atomic Absorption Spectrophotometry) (Ghanem, 2021; Harun et al., 2021). Utilization water Lake Toba which very variety give impact to drop quality the water, where Lake Toba also used as the place throw away various types of waste. The waste produced is in the form of organic waste that is easily decomposed by microorganisms and waste inorganic which difficult or no could unraveled by microorganisms, for example heavy metal.

Increased Floating Net Cage Business activities along the Lake Toba area accelerate the increase in the concentration of lead (Pb) and copper (Cu), this occurs because the waste from pellets that are not consumed by fish, go directly into water bodies. If this keeps happening to make a buildup harmful chemical compounds living things waters. Aquatic living things consist of from fish, shrimp, aquatic plant, etc. If the concentration of chemical compounds such as lead (Pb) and copper (Cu) high, probably already toxic for fish and no safe for consumed by man (Barus et al., 2022; Garno et al., 2020). Mercury and formalin could bioaccumulate and become toxic to cultured organisms. The excess of Hg and formalin on organism cultivation the cause disturbance on amount process physiological which cover the disturbance regulation exchange ion in gill so that lower absorption oxygen whose residues are bound to proteins and enzymes (Avigliano et al., 2019; Zill-e-Huma et al., 2021). One of the existing cultivated organisms in the waters Lake Toba is fish.

Fish is a food that contains high protein and contains acid amino essential which required by body, in side that score biology reach 90% with less connective tissue so it is easy to digest and the price is also much cheaper compared to other protein sources. In addition, fish is also used as an ingredient drugs, animal feed, and others. Nature metals heavy which no could unraveled and easy absorbed by biota sea and accumulates in the body, causing pollution. Apart from causing pollution ecosystems, chemical compounds also indirectly damage fisheries and health man (Mason & Brown, 2014; Situmorang & Simatupang, 2021). If humans continue to consume fish contaminated with mercury and formalin then will cause impaired vision, impaired accommodation and balance of the eye muscles, the possibility of deafness, disturbances in the function of the balance apparatus, pale skin, disturbances speech is mainly found in poisoning organic lead (Pb) and copper (Cu), damage the cells of the internal physiology tissue body damage such as liver, kidney, gastrointestinal tract or exchange of waste substances (metabolism) of body tissues can not work properly and will cause death. For resolve Thing the so need conducted study on fish for prevent poisoning in humans. This research was conducted on freshwater fish found in the waters of Lake Toba, North Sumatra because these freshwater fish are the site of physical, chemical, and biological reactions that will be experienced by heavy metals when entering the waters, so there is possibility for accumulated (Kafiar et al., 2013).

The purpose of this study was to determine the concentration of heavy metals lead (Pb) and copper (Cu) in the waters of Lake Toba, North Sumatra. The benefits of research are in the form of information, analysis and study of heavy metals lead (Pb) and copper (Cu) in the waters of Lake Toba, North Sumatra and become a material for consideration in the formulation of policies, considerations in the formulation of policies for the management of the waters of Lake Toba, North Sumatra, so that the use of resources which there is can be done by sustainable (Fukushima et al., 2023; Hardjo, 2005). Metal inside food something is working as a mineral that is needed and there is a role as contamination . Metals that act as contaminants. metal acts as a contaminant, usually in the form of heavy metals. All heavy metals can be

poison which will poison the body of the creature life (Khan et al., 2021; Medunić et al., 2020). Fish are a type of aquatic organism that can move quickly in water. Because could swimming with fast, fish have ability avoid self from the effects of pollution. But in fish that live in limited habitats such as rivers, lakes, and bays, it is difficult to escape from the effects of such pollution. Heavy metal content in fish is closely related to the disposal of industrial waste around where the fish live the, such as rivers, lakes and oceans. Taking beginning metal by living things water through three process main: (1) from water through respiratory surfaces (eg, gills); (2) absorption from water to in the body surface; and (3) from food, particles or water ingested through the system digestion. The mechanisms involved in metal uptake in fish can be deduced that in water, process absorption similar on crustaceans which more big. Metal seldom absorbed by the gills through a passive process, because the level of concentration The corresponding gain is achieved by metal uptake in gill-covering mucus and accumulation of brief levels in in gills. Absorption from food which digested more important (Nurhamiddin & Ibrahim, 2018; Osesua et al., 2019). The distribution and accumulation of these metals is very different for each aquatic organism. It depends on the species, metal concentration in water, pH, growth phase and ability to relocate. Certain metals are usually concentrated in species certain species in the sea and these species usually have high species levels, such as fish whale and tuna.

Metal adsorption, in addition to entering through the gills can also enter through the skin (cuticle) and the mucosal layer. Metals adhere to cell surfaces, body fluids and internal tissues. Connection between quantity absorption metal and content metal in water usually proportionally, where increase content metal in network usually in accordance with increase metal content in water (Puspitasari et al., 2018; Sadeghi et al., 2020). Several factors affect the rate of metal absorption from the water, that is, the level of salt (sea water), alkalinity (fresh water), the presence of other chemical compounds, temperature, pH, large small organism, and condition starving from organism. Although so, The tolerance of an organism to heavy metals does not depend on the rate of absorption of the metal into the metal body. In addition, physiological stress conditions greatly affect metal absorption from water, this condition cause to happen increase metal absorption.

The interaction of matter with various energies such as heat energy, radiant energy, chemical energy and energy electricity always give traits which Specific for every element. The size change which occur comparable with amount element or compound which is in it. This interaction process underlies atomic spectrophotometric analysis in the form of emission and absorption (Siringoringo et al., 2022; Syaifullah et al., 2018). Destruction is the process of oxidative destruction of organic matter prior to determination an inorganic analyte or to break bonds with metals. So that these elements do not interfere with each other in the analysis, then one element is omitted, with With the destruction process, it is hoped that only the metals will be left behind. In destruction should choose oxidizing agent which suitable for metal or the type of sample to be analyzed. There are two types of destruction, namely wet destruction and wet destruction dry (Situmorang & Simatupang, 2021; Tanjung et al., 2022). Wet digestion can determine elements with high concentrations low. Wet digestion is carried out by decomposing organic matter in solution concentrated oxidizing acid (H 2 SO 4 , HNO 3 , H 2 O 2 and HClO 4) by heating until clear. Inorganic minerals will remain and dissolve in strong acid solutions. Minerals are in metal cations form and chemical bonds with organic compounds have been broken down. Next solution filtered and ready to be analyzed with SSA (Syaifullah et al., 2018; Wulandari & Sukesi, 2013). Validation of the analytical method is an act of assessing certain parameters, based on laboratory experiments, to prove these parameters meet requirements for its use. Action this conducted for ensure that method analysis accurate, Specific, reproducible and stand will range analyte which will analyzed.

2. METHOD

This research is descriptive in nature, namely knowing the description of the heavy metal content of lead (Pb) and copper (Cu). on a number of fish water bid in Lake Toba, Sumatra North. Study this held August - September 2022 with the venue in the waters Lake Toba, Sumatra North. The method used is a survey method that is looking at the concentration of Pb and Cu on meat fish water bid in waters Lake Toba, Sumatra North. For 3 station different sampling. Pick up station point sample is non-probability and purposive sampling, namely sampling without opportunity and because of consideration certain deliberately chosen (Sugiyono, 2019).

Sample Pb and Cu water taken with use bottle sample sized 250 ml which three drops of nitric acid solution have been dripped according to the sample preparation technique, the water sample is labeled in accordance with point taking and saved in in cool box for ready in analysis. Sampling of Pb and Cu in fish meat was carried out by catching fish at locations At the specified station, the type of fish has been determined, namely freshwater fish measuring 40-60 cm (± 1.2 kg). The fish was dissected with

surgical instruments and the meat on the upper back was taken fish. The meat is stored in the sample bottles that have been provided. This procedure in do During period taking sample and apply for all point or station taking. Content Hg on water and meat tested with analysis Atomic Absorption Spectrophotometer (AAS) and observed also Factor Concentration (FK) that is is ratio of the metal content in the fish body to the metal content in the assessed water with accumulation level categories, namely: FK < 100 (low), 100 < FK 1000 and FK > 1000 (tall). The data obtained are presented in the form of tables and graphic images and then analysis by descriptive (Yusof et al., 2022).

To test the heavy metal Pb and Cu, 2 types of fish to be taken as samples fish, where the inspection will begin from fish measuring 1 kg, 0.5 kg and 0.3 kg. So that will be taken 3 fish on each sample freshwater fish in Lake Toba, North Sumatra, namely 1 fish for 1 kg fish, 1 fish for large fish 0.5 kg and 1 more for 0.3 kg fish. Sampling method conducted with method purposive sampling. Analysis content heavy metals Pb and Cu on fish fresh carried out at the UPT. Laboratory Regional Health Health Office of North Sumatra Province (Yusuf et al., 2013). The method used is with method titration.

3. RESULT AND DISCUSSION

Result

Study this has held on month August -September 2022 in region waters Lake Toba. Analysis data held at UPT. Regional Health Laboratory , North Sumatra Provincial Health Office. Determination location study this conducted with use method *purposive sampling* . P retrieval data field which conducted in the form of data sample water, sample fresh water fish , as well as a number of parameter waters include ; temperature , salinity , brightness current , pH and DO conducted on all point station observation . Data results measurement parameter environment then tabulated and analyzed for knowing condition ecological waters by whole . Research data this obtained through four way , that is taking sample water, measurement parameter waters and taking fresh fish sample in field , next identification fresh fish in laboratory . Procedure work for analysis content metal weight of Pb and Cu in sample water use *Atomic Absorption Spectrophotometry* (AAS) refers to SNI 6989.8-2009 and SNI 6989.6-2009. Analysis sample fish bid for measure content metal heavy Pb and Cu use *A tomic Absorption Spectrophotometry* (AAS).

Accumulation Metal Heavy on Fresh Fish in waters

Study ability plankton accumulate metal Pb and Cu in waters Lake Toba, analyzed use factor bioconcentration (BCF). Analysis factor bioconcentration conducted based on content metal heavy in the biota divided with metal the weight contained in water. Factor bioconcentration is marine biota ability accumulate metal heavy which contained in habitats. If score factor b ioconcentration (BCF) > 1, means organism have ability concentrate metal in her body , on the contrary score factor bioconcentration (BCF) 1, means organism the not enough or no have ability concentrate metal in her body.

Connection Parameter waters with Content Metal Heavy on Freshwater Fish

Connection parameter waters with content metal heavy on fresh water fish determined with use equality multiple linear regression (*multiple regression*) where there is more from two variable free that is temperature , salinity , oxygen dissolved , pH and current . Analysis regression helped with use device soft SPSS with equality Y= a+b 1 X 1 +b 2 +X 2 +b 3 + X 3 + ... +b n + Xn +e . Utility analysis this is for predict score variable bound (Y) if variable free (X) exists two or more , for see big influence of water parameters to content metal weight in freshwater fish .

Characteristics waters Lake Toba

Waters Lake Toba is area waters located _ in Regency Simalungun . Regency Simalungun located within the region administration Province North Sumatra by geographical located on coordinates 2°21'32" – 2°56'28" North Latitude and 98°26'35" – 99°15'40" East Longitude are coordinate location Lake Toba on the map . Coordinate latitude north show that Lake Toba is located no far from equator . This is what causes Lake Toba and its surroundings have climate tropics , which time radiation sun almost the same in every the month .

Climate tropical this is also possible various species from plants and animals could develop with good on the lake this . Vegetation from various Plants can also be seen enough many around Lake this because soil volcanic its constituent fertile . By Administratively and geographically , Lake Toba is surrounded by 7 districts . Could imagine how much breadth Lake this . counties the is Regency Simalungun , Tobasa (Toba Samosir), North Tapanuli , Humbang Hasundutan , Dairi , Karo, and Samosir .
Lake Toba has size long around 100 kilometers with wide about 30 kilometers. Size the make Lake this enter in the list of 50 lakes largest in the world . Consequence breadth Lake this , access from side outside

Lake Toba to Island Samosir (in the middle lake) using fashion transportation in the form of ferries . Lake Toba has depth until 505 meters or equivalent with 1,666 feet, so that make it enter in the list of 10 lakes deepest in the world . Depth in various location on the lake this different , and things here as factor appearance miscellaneous species animal or the plants that live in it . Lake water surface area this is 1,124 km2 with surface a lake located at an altitude of 903 m above surface sea. Characteristics morphology Lake Toba has two basin main , that is basin north and basin south which is separated by the island Samosir . Depth , characteristics and location Unique Lake Toba this is what makes existence animal endemic the only special can found in the lake this . This thing already of course add diversity list flora and fauna in Indonesia . Animal the is a fish with name Latin Neolissochilus Thienemanni Sumtranus and species Corbicula Tobae clam . Unfortunately , the type animals the now already is at on the verge extinction. Lake Toba is one of the inheritance Indonesia's nature is very valuable and strategic . Place Lake Toba which is in the middle of 7 districts also plays a role as link and source activity the surrounding community. Like locations strategic other , lake not even this escape from damage nature caused by activity _ human because of that, let we take care together inheritance Indonesia's precious nature this , for continuity life Indonesian people especially local people Lake Toba.

Composition and Abundance Freshwater Fish in the Waters Lake Toba

Lake Toba is Lake the largest in Indonesia. Lake Toba as source water power which has very important value reviewed from function ecology , hydrology as well as the economy . Research in several area Lake Toba shows that plankton and benthic populations in Lake Toba are classified as low [4]. Plankton which consists of from phytoplankton and zooplankton is base in formation chain food . If population plankton low so Fish diversity in Lake Toba is also low . This thing is consequence from source nutrition main fish natural generally is various types of plankton and benthic . Deep nekton diversity Thing this is fish, found in Lake Toba as many as 14 species . Information obtained from fisherman local that types of fish lately this often got is a fish mujahir (*Tilapiam ossambica*), fish head tin (*Aplocheilus panchax*), fish one thousand (*Lebistes reticulates*), fish gourami (*Osphronem usgoramy*), fish shoes (*Trichogaster trichopterus*), fish cork (*Channa striata*), fish catfish (*Clarias batrachus*), fish mas (*Cyprinus carpio*), and fish indigo .

There is one type fish endemic i.e. " ihan " (*Neolissochilus thienemanni*). This type of fish based on criteria *International Union for the Conservation of nature* (IUCN) already threatened extinct (*endangered*). Found 10 species fish, that is *Cyprinus carpio* , *Osteochilus hasselti* , *Mystacoleucus Padangensis* , *Oxyeleotris marmorata* , *Channa striata* , *Oreochromis mossambica* , *Oreochromis niloticus* , *Chandra borvensis* , *Clarias batrachus* and *Cherax quadricarinatus* . With existence factor biotic like plant water could is known that waters still support continuity life organism aquatic inside _ like fish. Index diversity and uniformity type fish in Lake Toba Island Samosir belong to category low , while index dominance belong to in category high . By general abundance of fish biggest which caught fisherman in Lake Toba Island Samosir is type *Chandra borvensis* with abundance relatively as big as 97.10%. Type fish which found on every station in Lake Toba could seen on Table 1. Type of fish found in Lake Toba could seen on Figure 4.

Table 1. Fish Which Found on Every Station Study

No	Family	Genus	species	Amount fish at the station			
				I	II	III	IV
1	Cyprinidae	Osteochilus	*Osteochilus hasselti*			1	
2	cichlidae	*Oreochromis*	*Oreochromis mossambicus*		19	10	6
3			*Oreochromis niloticus*	1	3		
4		Amphilophus	*Amphilophus labiatus*	2	3	3	2
5			*Amphilophus Trimaculatus*			2	
6	Ambassidae	Parambass	*Parambass range*			2	
		Amount		**3**	**25**	**18**	**8**

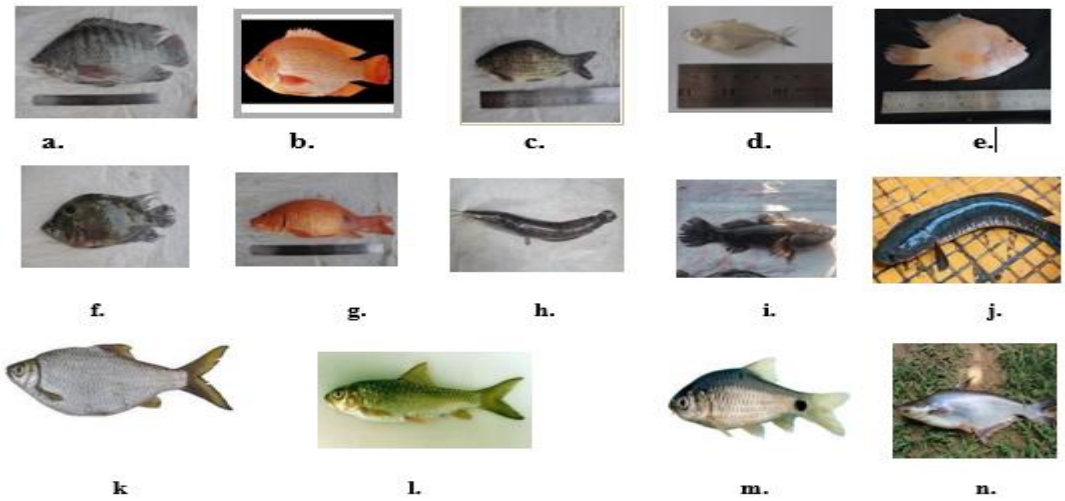

FIgure 1. Type Fish in Lake Toba

Base on Figure 1 in all station study get 6 types of fish namely : 1. Mujahir Fish (*Oreohormis mossambicus*), 2. Tilapia (*Oreohormis niloticus*), 3. Nilem fish (*Osteochilus hasselti),* 4. Glass Fish (*Parambassi ranga),* 5. Fish Red Devil (*Amphilophus labiatus)* , 6. Fish louhan (*Amphilophus trimaculantus)* , From the results Interview with fishermen and fish sellers in the market traditional so obtained 8 types of fish starting no.7 to with number 14, namely : 7, Goldfish (*Cyprinus carpio)* 8. Catfish (*Clarias batrachus)* 9. Fish Betutu (*Oxyeleotris marmorata)* , 10. Fish Cork (*Channa striata),* 11. Fish Bilih (*Mystacoleucus padangensis*) 12. Batak fish (*Neolissochilus thienemanni & Tor soro*) 13. Pora-Pora Fish (*Puntius binotatus)* 14. Fish Patin (*Pangasius djambal)* .

From four station observation Fish Mujahir and Fish Red devil dominate from side amount the catch compared with type fish other such as the Nilem Fish (*Osteochilus hasselti)* the least found . Existence the dominance of fish from the cichlidae family this because this type of fish life by clustered , and is very tolerant fish species , although second type fish this is type fish introduction , where process introduction the already in progress since long and already adapt so that make this fish easy breed . Existence species results introduction which dominate something waters will result in low level fish diversity , thing this caused with existence dominating type because more adaptive so species other no capable compete with him who finally lead on no stable something community even make community that Becomes depressed . Existence something types of fish in something waters are strongly influenced by presence of predators and competitors. Species found in all station study no same number , probability caused by habitat conditions. vegetation heterogeneous, state weather moment taking sample , and factor biotic , nor abiotic (physical and chemistry). Diversity fish in station I very a little, caused by conditions biotic and abiotic.

Condition the biotic that is many found watery goiter and along fringe station research . water hyacinth goiter is plant very invasive tolerant to various state environment . water hyacinth goiter could influence ecosystem , with lower amount species original , as well as cause impact negative to aspect social economy . Factor abiotic consequence settlement local people station research , so that on moment taking sample many found rubbish in surface water. Content phosphate and nitrate which obtained influence fertility Lake Toba in the village Sipinggan Nainggolan district districts Samosir , with low nutrient rate will cause low diversity the fish. Diversity fish in station II also low which caused by a lot watery goiter and cage net buoyant. Remnants gift feed and waste from cage could influence physical parameters chemistry the waters at last will influence fertility waters.

Diversity types of fish on the fourth station , more many found in station III, p this caused more a little cage net floating and settlement surrounding residents . Factor physics the chemistry good in districts order will take effect to its diversity. Diversity type fish low in station IV, found a little watery goiter , settlement population , and fish farming in cage net buoyant . Many stones are found from small ones up to size big with condition little land muddy. Condition waters districts Simanindo already polluted so that influence diversity fish in in it. Diversity type influenced by distribution or deployment individual in every kind, because something community although many kind but when deployment no equally so diversity type rated low. Index diversity state riches species in community and show balance in distribution individuals per species. Lack of amount species found even lack of amount endemic species found in Lake Toba can because not enough optimal tool catch used and also the limitations time as well as the area used location observation only part small from large whole.

Discussion

Content Metal Heavy in Water

Content metal heavy in waters Lake Toba served on Figure 2.

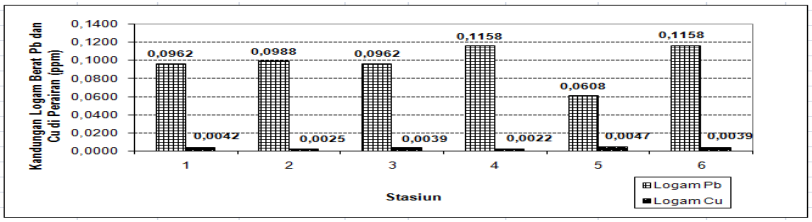

Figure 2. Comparison Content Metal Weight of Pb and Cu in Water Lake Toba

Base on Figure 2 show the results analysis concentration metal heavy Pb and Cu in waters Lake Toba show concentration Pb metal in water ranges from 0.0608 – 0.1158 ppm while for Cu . metal range 0.0022 – 0.0047 ppm. Potency height metal heavy Pb in waters Lake Toba this suspected through existence activity then cross cruise and the place port . Activity then cross cruise cause spill ingredient burn boat which contain metal Pb to waters . Source metal heavy other like results from existence activity disposal water ballast in location port , is ingredient pollutant on water which mixed with compound oil or ingredient burn there is in body ship.

Existence settlement in fringe waters Lake Toba is one of the potency metal the weight in exile waste house ladder to the body waters . Waste house ladder from coast usually found in form trash , existence water outhouse (*black water*), and the presence of waste water from various activity domestic other (*grey water*). In general waste house ladder have role in donate metal in environment waters . discard generated like trash metabolic , pipe corrosion pipe water which could produce metal among them Pb and Cu in waters Lake Toba.

Content Metal Heavy in Freshwater Fish

Content metal heavy in plankton in the water Lake Toba served on Figure 3.

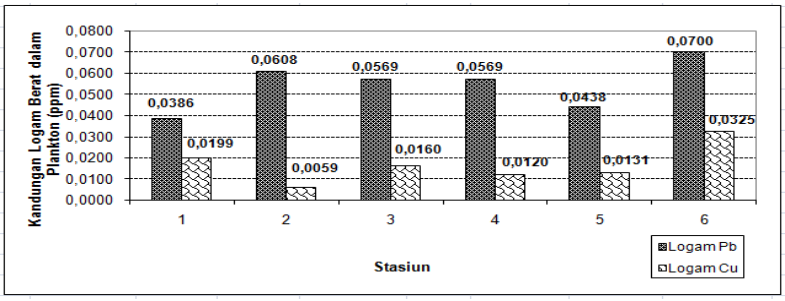

Figure 3. Comparison Content Metal Heavy Pb and Cu in Fresh Water Fish in Waters Lake Toba

Based on Figure 3 can seen score metal heavy Pb in plankton ranges from 0.0386 to 0.0700 ppm and for score metal weight of Cu in plankton ranged from 0.0059 to 0.0325 ppm. Results the same case with condition metal heavy Pb and Cu in waters. Condition this state that concentration Pb metal in water and more plankton tall compared with concentration Cu metal in water and plankton. By general the more tall Pb content in waters , so content Pb in plankton the more high [8]. Condition this give definition that rate metal Pb in plankton along follow concentration metal Pb which there is in waters . Although on metal data condition heavy in water and plankton got no always compared to straight , Thing this suspected by existence limitations reading tool or instrument detect metal on moment test sample plankton. Different case with condition metal heavy Cu in water and in in plankton, where metal weight of Cu in plankton value precisely more big than value _ metal weight of Cu in water. Case this compared to backwards to condition metal weight of Pb in water and di in plankton. This thing suspected existence enhancement concentration metal Cu yang dissolved in waters on location certain, outside point station research . So that the bioaccumulation process in progress until reach point saturated in plankton cells. Condition this showed by existence activity accumulation Cu metal excessive, so that no capable processed in metabolism body plankton.

Accumulation Metal Heavy on Plankton in waters

Results from observation about bioaccumulation or interaction Among biota waters specifically plankton to potency metal heavy in waters or more known with factor bioconcentration (BCF) served on Figure 4.

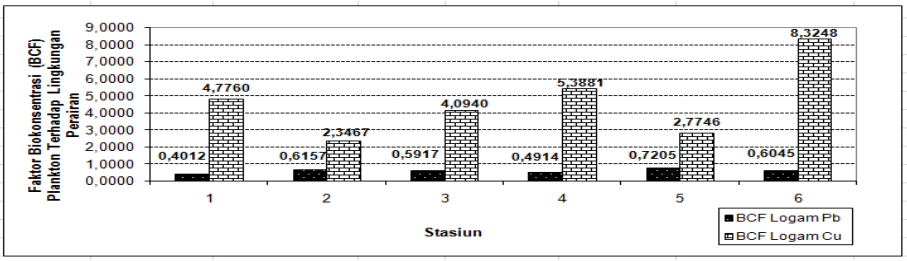

Figure 4. Comparison Score Factor Plankton Bioconcentration (BCF) to Metal Pb and Cu

Based on Figure 4, seen that score factor freshwater fish bioconcentration to Cu metal in water more tall compared with score factor bioconcentration plankton to Pb metal , BCF value against metal Cu range 2,347 – 8,325 whereas BCF value against Pb . metal range 0.401 – 0.721. If score factor bioconcentration (BCF) > 1, means organism have ability concentrate metal in her body , on the contrary score factor bioconcentration (BCF) 1, means organism the not enough or no have ability concentrate metal in her body .

Connection Parameter waters To Metal Heavy in Freshwater Fish

Calculation result through analysis regression linear multiple connection Among metal heavy in plankton to condition parameter waters which helped by application (*Statistical Product and Service solutions)* SPSS 16 with equality (Y = a + b 1 X 1 + b 2 X 2 + b 3 X 3 +...+ b n X n + e) is shown in model summary could seen on Picture 6 and Picture 7. Model summary is coefficient correlation Prearson which show level connection Among variable concentration metal weight and environmental parameters waters. Correlation this is wrong one size correlation which used for measure strength and direction linear relationship of two variable. Two variable said correlated if change one variable accompanied with change variable other, good in direction which same or direction which otherwise. The result of analysis of Pb and Cu is show in Table 2 and Table 3.

Table 2. Model *Sumarry* Water Parameter Relationship to Metal Heavy Pb in Freshwater Fish

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.734	0.538	0.346	0.0071153

Table 3. *Model* Water Parameter Relationship to Metal Heavy Cu in Freshwater Fish

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.798	0.636	0.485	0.0083778

Base on Table 2 and Table 3 show results analysis regression multiple linear performed _ for metal heavy Pb and Cu in plankton to parameter waters each each have coefficient correlation with the value of R = 0.798 and R = 0.734. R value indicates that content metal Pb and Cu in plankton relate enough close to condition parameter waters . This thing state that on analysis this have or existence connection for every parameter waters which be measured cover temperature , salinity , oxygen dissolved , pH and current . As temperature play a role in exchange substance in in body plankton. Salinity , oxygen dissolved and pH play a role in process solubility metal in water and influence physiology as well as metabolism on plankton. Current play a role as process transportation and stirring substances in waters who can accumulated by plankton. So, whole parameter waters have role and function each each to content metal heavy Pb and Cu in plankton. The more tall score coefficient correlation could give definition the more good also connection parameter waters to metal heavy in plankton. Coefficient determination on metal Pb and Cu in plankton to parameter waters each with value of R 2 = 0.636 and R 2 = 0.538. R value 2 indicates that content metal heavy Pb in plankton influenced by condition environmental parameters waters as big as 63.6 % whereas content metal heavy Cu in plankton influenced by parameter environment as big as

53.8 %. If you pay attention score coefficient determination on metal Pb and Cu in plankton as variable bound have difference connection to variable free each with values 63.6% and 53.8%. Condition this suspected by existence difference level content metal more Pb weight high in the water Lake Toba compared with condition Cu metal. The more high content metal in waters which related close with condition environmental parameters so content each metal Pb and Cu in fresh water fish the more high.

4. CONCLUSION

Concentration metal heavy which contained in the plankton in the waters Lake Toba range 0.0386 – 0.0700 ppm for score metal weight of Pb and 0.0059 – 0.0325 ppm for score metal Cu weight . Factor value bioconcentration (BCF) plankton to metal Cu range 2,347 – 8,325 plankton have ability in concentrate metal Cu inside his body , while score factor bioconcentration (BCF) plankton to metal Pb range 0.401 – 0.721 freshwater fish no could concentrated in in body plankton. There is connection which enough close to metal weight of Pb and Cu in fresh water fish which influenced by parameter waters.

5. REFERENCES

Adagunodo, T. A., Sunmonu, L. A., & Emetere, M. E. (2018). Heavy metals' data in soils for agricultural activities. *Data in Brief*, *18*, 1847–1855. https://doi.org/10.1016/j.dib.2018.04.115.

Ahamad, M. I., Song, J., Sun, H., Wang, X., Mehmood, M. S., Sajid, M., Su, P., & Khan, A. J. (2020). Contamination level, ecological risk, and source identification of heavy metals in the hyporheic zone of the Weihe River, China. *International Journal of Environmental Research and Public Health*, *17*(3), 1070. https://doi.org/10.3390/ijerph17031070.

Amelia, F., Ismarti, I., Ramses, R., & Rozirwan, R. (2019). Biokonsentrasi Faktor Logam Berat pada Kerang dari Perairan Batam, Kepulauan Riau, Indonesia. *EduChemia (Jurnal Kimia Dan Pendidikan)*, *4*(2), 152. https://doi.org/10.30870/educhemia.v4i2.5529.

Anggraini, W., & Puryanti, D. (2019). Identifikasi Pencemaran Logam Berat Tembaga (Cu), Timbal (Pb) dan Kadmium (Cd) Air Laut di Sekitar Pelabuhan Teluk Bayur Kota Padang. *Jurnal Ilmu Fisika Universitas Andalas*, *11*(2), 95–101. https://doi.org/10.25077/jif.11.2.95-101.2019.

Avigliano, E., Clavijo, C., Scarabotti, P., Sánchez, S., Llamazares Vegh, S., del Rosso, F. R., Caffetti, J. D., Facetti, J. F., Domanico, A., & Volpedo, A. V. (2019). Exposure to 19 elements via water ingestion and dermal contact in several South American environments (La Plata Basin): From Andes and Atlantic Forest to sea front. *Microchemical Journal*, *149*, 103986. https://doi.org/10.1016/j.microc.2019.103986.

Barus, T. A., Wahyuningsih, H., & Hartanto, A. (2022). Water Quality and Trophic Status of Lake Toba, North Sumatra, Indonesia. *Hydrobiological Journal*, *58*(2), 34–43. https://doi.org/10.1615/HydrobJ.v58.i2.30.

Fukushima, T., Setiawan, F., Subehi, L., Jiang, D., & Matsushita, B. (2023). Water temperature and some water quality in Lake Toba, a tropical volcanic lake. *Limnology*, *24*(1), 61–69. https://doi.org/10.1007/s10201-022-00703-4.

Garno, Y. S., Nugroho, R., & Hanif, M. (2020). Kualitas air Danau Toba di wilayah Kabupaten Toba Samosir dan kelayakan peruntukannya. *Jurnal Teknologi Lingkungan*, *21*(1), 118–124. https://doi.org/10.29122/jtl.v21i1.3277.

Ghanem, M. (2021). Bioaccumulation of Some Heavy Metals in Chrysichthys rueppelli Collected from El-Bagouria Canal at El-Menoufia Governorate, Egypt. *Egyptian Academic Journal of Biological Sciences. C, Physiology and Molecular Biology*, *13*(2), 215–228. https://doi.org/10.21608/eajbsc.2021.209381.

Hardjo, M. (2005). Tepung Gadung (Dioscorea Hispida DENNST) Bebas Sianida dengan Merendam Parutan Umbi dalam Larutan Garam. *Matematika, Sains, Dan Teknologi*, *6*(2), 92–99. https://jurnal.ut.ac.id/index.php/jmst/article/view/652.

Harun, I., Pushiri, H., Amirul-Aiman, A. J., & Zulkeflee, Z. (2021). Invasive Water Hyacinth: Ecology, Impacts and Prospects for the Rural Economy. *Plants*, *10*(8), 1613. https://doi.org/10.3390/plants10081613.

Kafiar, F. P., Setyono, P., & Ramelan, A. H. (2013). Analisis Pencemaran Logam Berat (Pb dan Cd) Pada Sapi Potong di Tempat Pembuangan Akhir (TPA) Sampah Putri Cempo Surakarta. *Ekosains*, *5*(2). https://www.researchgate.net/profile/Agus-Suyanto-5/publication.

Kartamihardja, E. S., Fahmi, Z., & Umar, C. (2015). Zonasi ekosistem perairan Danau Toba untuk pemanfaatan perikanan berkelanjutan. *Jurnal Kebijakan Perikanan Indonesia*, *7*(1), 1–8. http://ejournal-balitbang.kkp.go.id/index.php/jkpi/article/view/1.

Khan, Z. I., Mansha, A., Saleem, M. H., Tariq, F., Ahmad, K., Ahmad, T., Farooq Awan, M. U., Abualreesh, M. H., Alatawi, A., & Ali, S. (2021). Trace Metal Accumulation in Rice Variety Kainat Irrigated with Canal Water. *Sustainability*, *13*(24), 13739. https://doi.org/10.3390/su132413739.

Mansor, H. E., Idris, F. H., Khan, M. M. A., James, E., Ghazali@Ghali, Z. Z., & Shah, Z. A. (2022). Physical and chemical characteristics of bottom sediments from the Kelantan river, Tumpat, Kelantan. *AIP Conference Proceedings*, *2454*(1), 050025. https://doi.org/10.1063/5.0078693.

Mason, C., & Brown, R. (2014). Entreprenuerial Ecosystem and Growth Oriented. *OECD*, *30*(1), 77–102. https://www.researchgate.net/profile/Colin-Mason-2/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP_Background_paper_prepared_for_the_workshop_organised_by_the_OECD_LEED_Programme_and_the_Dutch_Ministry_of_Economic_Aff.

Medunić, G., Fiket, Ž., & Ivanić, M. (2020). Arsenic Contamination Status in Europe, Australia, and Other Parts of the World. In *Arsenic in Drinking Water and Food* (pp. 183–233). Springer Singapore. https://doi.org/10.1007/978-981-13-8587-2_6.

Nasution, M. I. T., Awal, S. M. S., & Permana, D. M. (2016). The methods of preventing water hyacinth as aquatic pollution in Lake Toba caused by agricultural waste. *Int. J. Environ. Sci. Dev*, *7*, 630–633. https://www.academia.edu/download/71060852/852-M0011.pdf.

Nurhamiddin, F., & Ibrahim, M. H. (2018). Studi pencemaran logam berat timbal (Pb) dan tembaga (Cu) pada sedimen laut di Pelabuhan Bastiong Kota Ternate Propinsi Maluku Utara. *DINTEK*, *11*(1), 41–55. https://jurnal.ummu.ac.id/index.php/dintek/article/view/139.

Oladipo, S. O., Adeniyi, T., & Anifowoshe, A. (2020). Histological and Hepatic Enzymes Response of Oreochromis niloticus and Clarias anguillaris to Pollution in Asa River, Ilorin. *Journal of Life and Bio Sciences Research*, *1*(01), 16–21. https://doi.org/10.38094/jlbsr114.

Osesua, B. A., Abubakar, U., Ramatu, L. Y., & Aliyu, A. K. (2019). Assessment Of Heavy Metals Accumulation In Fish, Sediments And Water From Yauri River, Kebbi State, Nigeria. *Academic Journal of Current Research*, *6*(11), 69–82. https://academicjournals.org/journal/JECE/article-full-text-pdf/4CC4E3E3307.

Puspitasari, L., Herdini, H., & Fauziah, S. (2018). Analisis Merkuri (Hg) dalam Ikan Air Tawar di Pasar Depok dengan Metode Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). *Sainstech Farma: Jurnal Ilmu Kefarmasian*, *11*(2), 5–10. https://doi.org/10.37277/sfj.v11i2.388.

Rahmat, R. F., Syahputra, M. F., & Lydia, M. S. (2016). Real time monitoring system for water pollution in Lake Toba. *In 2016 International Conference on Informatics and Computing (ICIC)*, 383–388. https://doi.org/10.1109/IAC.2016.7905749.

Raja, G. A. L., Retno, R., & Sitompul, S. (2023). Studi Kualitas Air Di Perairan Danau Toba Kecamatan Ajibata Kabupaten Toba. *ARMADA: Jurnal Penelitian Multidisiplin*, *1*(7), 640–650. https://doi.org/10.55681/armada.v1i7.657.

Sadeghi, P., Loghmani, M., & Frokhzad, S. (2020). Human health risk assessment of heavy metals via consumption of commercial marine fish (Thunnus albacares, Euthynnus affinis, and Katsuwonus pelamis) in Oman Sea. *Environmental Science and Pollution Research*, *27*(13), 14944–14952. https://doi.org/doi.org/10.1007/s11356-020-07907-0.

Siringoringo, V. T., Pringgenies, D., & Ambariyanto, A. (2022). Kajian Kandungan Logam Berat Merkuri (Hg), Tembaga (Cu), dan Timbal (Pb) pada Perna viridis di Kota Semarang. *Journal of Marine Research*, *11*(3), 539–546. https://doi.org/10.14710/jmr.v11i3.33864.

Situmorang, I. M., & Simatupang, D. F. (2021). Analisis Logam Berat Pada Sayuran Yang Ditanami Di Pinggir Jalan Bekasi Utara. *Jurnal Analis Laboratorium Medik*, *6*(1), 19–22. https://doi.org/10.51544/jalm.v6i1.1837.

Sugiyono. (2019). Metode Penelitian Pendidikan. In *Bandung:Alfabeta*.

Susanto, J. P., Riyadi, A., & Garno, Y. S. (2021). Kelayakan Air Danau Toba di Wilayah Kabupaten Tapanuli Utara untuk Air Baku dan Wisata Air. *Jurnal Teknologi Lingkungan*, *22*(2), 231–239. https://doi.org/10.29122/jtl.v22i2.4853.

Syaifullah, M., Candra, Y. A., Soegianto, A., & Irawan, B. (2018). Kandungan Logam Non Esensial (Pb, Cd Dan Hg) Dan Logam Esensial (Cu, Cr Dan Zn) Pada Sedimen Di Perairan Tuban Gresik Dan Sampang Jawa Timur. *Jurnal Kelautan: Indonesian Journal of Marine Science and Technology*, *11*(1), 69. https://doi.org/10.21107/jk.v11i1.4497.

Tanjung, D., Parulian Hutagaol, M., Kriswantriyono, A., Puji Hastuti, Y., Nirmala, K., & Wulandari, Y. (2022). Regulatory Impact Assessment Analysis of Regulations on Pollution Load Capacity and Carrying Capacity of Lake Toba for Aquaculture Fisheries. *E3S Web of Conferences*, *348*, 00037. https://doi.org/10.1051/e3sconf/202234800037.

Wulandari, E. A., & Sukesi, S. (2013). Preparasi Penentuan Kadar Logam Pb, Cd dan Cu dalam Nugget Ayam Rumput Laut Merah (Eucheuma cottonii). *Jurnal Sains Dan Seni ITS*, *2*(2), C15–C17. https://doi.org/http://dx.doi.org/10.12962/j23373520.v2i2.3729.

Yusof, A. M., Kamaruddin, S. A., Nasir, N. A. N. M., & Zakarya, I. A. (2022). Assessment of aquatic toxicology dataset using MLR. *AIP Conference Proceedings*, *2472*(1), 050026. https://doi.org/10.1063/5.0094883.

Yusuf, M., Hamzah, B., & Rahman, N. (2013). Kandungan merkuri (Hg) dalam air laut, sedimen, dan jaringan ikan belanak (Liza melinoptera) di perairan Teluk Palu. *Jurnal Akademika Kimia*, *2*(3), 140–145. http://jurnal.untad.ac.id/jurnal/index.php/JAK/article/view/7761.

Zill-e-Huma, Khan, Z. I., Noorka, I. R., Ahmad, K., Wajid, K., Nadeem, M., Munir, M., Malik, I. S., Kiran, M., Hussain, T., Qamar, M. F., Ahmad, T., Rehman, S. U., & Ullah, M. F. (2021). Appraisal of chromium in chicken reared on maize irrigated with sewage water. *Environmental Science and Pollution Research*, *28*(9), 11509–11517. https://doi.org/10.1007/s11356-020-11393-9.