e-ISSN: 3030-878X

The 5th International Conference on Environmental Health **(ICoEH)**

Microplastic Content in Tilapia (Oreochromis mossambicus) Milkfish (Chanos chanos) at Benowo Market, Benowo Village, Pakal Sub-district, Surabaya in 2025

Ersa Afianti[1], Iva Rustanti[2*], Marlik[3], Ferry Kriswandana[4], Imam Thohari[5]

[1,2,3,4,5] Environmental Health Department, Ministry of Health Polytechnic of Health, Surabaya, Indonesia
**Corresponding author: ivarust.eri@poltekkesdepkes-sby.ac.id*

ABSTRACT

Background: Microplastics posed significant threats to both aquatic ecosystems and human health. Tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) were among the commonly consumed fish species that were cultivated in fishponds around the Benowo area. The proximity of these ponds to the Benowo Final Waste Disposal Site raised concerns regarding potential microplastic contamination due to environmental pollution. **Object:** This study aimed to identify the presence and characteristics of microplastic particles in the bodies of tilapia and milkfish sold at Benowo Market, Surabaya. The results were intended to provide early insight into food safety risks associated with fish consumption in areas near unmanaged waste disposal. **Methods:** This research was a descriptive study with a qualitative approach. The objects of the research were tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) sold at Benowo Market. The research variable focused on the presence of microplastics. Data were collected through observation, documentation, and laboratory testing using a stereo microscope. The results were analyzed descriptively. **Results:** The results showed that most of the tilapia and milkfish samples examined contained microplastics. Microplastics were identified mainly in the digestive organs and, to a lesser extent, in the flesh. Fiber-shaped microplastics were more dominant than fragments. After the frying process, microplastics were still detected in the flesh of both fish species. **Conclusion:** This indicated that microplastic particles remained intact even after being exposed to high temperatures during cooking, and thus posed a potential risk of entering the human food chain. Further research was recommended to identify the polymer types of the detected microplastics using FTIR or GC-MS methods in order to assess their possible impacts on human health more comprehensively.

Keywords: Microplastic, Tilapia fish, Milkfish, Benowo market, Polymer

BACKGROUND

Plastic is a type of non-organic waste with many uses. However, its resistant nature makes it extremely difficult to degrade in the soil, often taking hundreds of years to decompose. This characteristic renders plastic a pollutant with negative environmental impacts if not managed and utilized wisely. This situation contributes significantly to the increasing volume of plastic waste (Nirmalasari, 2021).

Plastic waste has the potential to contaminate both soil and water, posing threats to human health and the survival of marine life. The presence of plastic waste has become a major environmental pollution issue (Sustainability, 2024). Plastic undergoes oxidative degradation of polymers in the environment due to exposure to ultraviolet radiation. The breakdown results in the formation of smaller particles known as microplastics, which can also be triggered by various mechanical factors, such as wind, ocean waves, feeding activities by aquatic organisms, and anthropogenic actions (Permatasari & Radityaningrum, 2020).

Microplastics (MPs) are fragments of all types of plastic measuring less than 5 mm (0.20 inches) in length, according to the National Oceanic and Atmospheric Administration (NOAA) and the European Chemicals Agency (ECHA) (Dewi, 2022). These small-sized plastic particles pose a high risk of being ingested by aquatic organisms. Once inside the organism's body, microplastics can cause internal organ damage, blockages in the digestive tract, and reduced reproductive success and survival rates of aquatic organisms (Aliyansyah & Holil, 2024). Fish are among the most vulnerable aquatic organisms to this contamination.

Benowo aquaculture ponds are one of the fish farming areas that support the local community's economy by serving as a primary livelihood source. However, the proximity of these ponds to the Benowo Landfill raises serious concerns about environmental pollution, including microplastic contamination. Leachate from the landfill can potentially enter surrounding aquatic environments, thereby increasing the risk of microplastic accumulation in the ponds. This situation raises concerns about the quality and safety of farmed fish.

Tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) are among the aquatic commodities widely cultivated in Benowo ponds and sold at Benowo Market, Surabaya. Tilapia is a freshwater fish species known for its higher reproductive capability compared to other freshwater fish. This species is widely distributed across Indonesia and is commonly cultivated due to its high protein content and favorable taste, making it a preferred source of nutrition for the public (Moko et al., 2021). Milkfish (Chanos chanos) is one of the most well-known and popular edible fish species in Indonesia. It is considered a promising aquaculture commodity due to its resilience to environmental changes. Milkfish has several advantages, including ease of maintenance and resistance to disease (Buwono, 2021).

Fish generally feed on natural organisms available in aquatic habitats, including pond environments. Microplastics can enter fish either through the direct ingestion of suspended plastic particles in the water or indirectly through the consumption of contaminated food in the food chain. This accumulation process is a serious concern due to its potential physiological effects on fish and health risks to humans who consume them (Yona et al., 2020). The presence of microplastics in food sources poses a threat to human health (Ilmiawati et al., 2022). Microplastics are recognized as toxic contaminants that can cause oxidative stress, inflammation, and increased absorption of harmful substances in the body. Research has revealed that microplastics may lead to metabolic disorders, neurotoxicity, and an increased risk of cancer. Moreover, microplastics are associated with physiological disorders and are capable of penetrating the digestive tract and migrating into muscle tissue through a mechanism known as translocation. This raises concerns about food safety, especially in fish consumed along with their muscle tissues.

This study aimed to identify the microplastic content in tilapia and milkfish sold at Benowo Market, Surabaya. The study also examined the types and presence of microplastics before and after the frying process, and analyzed the potential health risks associated with the consumption of fish contaminated with microplastics.

RESEARCH METHODS

Materials and Method

This study employed a descriptive research design with a qualitative approach. The objects of the research were tilapia (Oreochromis mossambicus) and milkfish

(Chanos chanos) sold at Benowo Market. The research variable focused on microplastic content. Samples were selected using purposive sampling, in which specimens were intentionally chosen based on their known origin from fishponds near the Benowo landfill area. Data were collected through observation, documentation, and laboratory testing using a stereo microscope. The results of the study were analyzed descriptively.

Fish Sampling and Preparation

The fish samples used in this study consisted of tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) obtained from Benowo Market. A total of six fish were selected based on predetermined criteria, comprising three tilapia and three milkfish. The sampling was conducted in June 2025. The fish samples were stored in a cool box and transported to the laboratory for analysis.

Each fish was rinsed with distilled water (aqua destillata) to remove dirt and external particles. Dissection was then performed using sterile surgical knives to separate the digestive organs and muscle tissue. The whole fish was divided into two parts, the upper section was used to collect the digestive organs, while the lower section was used to collect muscle tissue. The muscle samples were further divided into two treatment groups: without frying and after frying. The frying process was carried out for approximately 10 minutes at an oil temperature of 170–190°C. Once cooled, the muscle tissue samples were ground using a glass mortar and pestle to facilitate microplastic identification.

Preparation and Extraction of Microplastics from Fish Tissues

Samples of fish digestive organs and muscle tissue were digested using a 10% potassium hydroxide (KOH) solution, with 20 mL or sufficient volume added to fully submerge the tissues. The samples were then incubated at 40°C for 48 hours until the tissues were completely digested. After digestion, the samples were filtered using Whatman filter paper attached to a funnel. The retained filtrate on the filter paper was transferred onto a petri dish and dried in an oven at 60°C for 24 hours. Once dried, the samples were examined under a stereo microscope to identify the presence and morphology of microplastics. The data obtained were recorded and analyzed descriptively using a qualitative approach.

RESULTS AND DISCUSSION

The results of the study showed that some samples of tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) purchased at Benowo Market contained microplastics in both the digestive organs and muscle tissues. Microplastics were detected in 100% of the digestive tract samples. In contrast, 66.7% of the muscle (flesh) samples contained microplastics, while 33.3% did not show the presence of microplastics. After the frying process, microplastics remained detectable in all muscle tissue samples, accounting for 100%.

Table 1.
Microplastic Content in Tilapia (Oreochromis mossambicus) and Milkfish (Chanos chanos) Sold at Benowo Market in 2025

	Examined Part	Microplastic	Number of Samples	%
Without frying procces	Digestive organs	Present	6	100%
	Muscle Tissue	Present	4	66,7%
		Not present	2	33,3%
After frying procces	Muscle Tissue	Present	6	100%

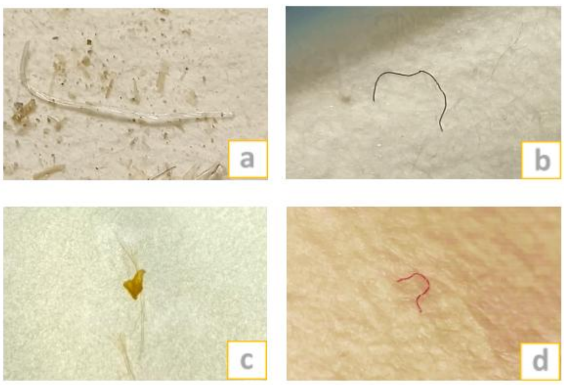
Observations under a stereo microscope revealed the presence of microplastic particles in the form of fibers and fragments within the digestive organs and muscle tissues of tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos). Fiber-shaped microplastics were predominantly observed in the digestive tract, while fragments were mainly detected in the muscle tissues, particularly after the frying process.

Table 2.
Identification of Microplastic Content in Tilapia (Oreochromis mossambicus) and Milkfish (Chanos chanos) Sold at Benowo Market in 2025

No.	Sample	Examined part	Microplastic	Form of Plastic
Without Frying Procces				
1.	Tilapia 1	Digestive organs	Present	Fiber
2.	Tilapia 2		Present	Fiber
3.	Tilapia 3		Present	Fiber
4.	Milkfish 1		Present	Fiber
5.	Milkfish 2		Present	Fragment
6.	Milkfish 3		Present	Fiber
7.	Tilapia 1	Muscle Tissue	Not present	-
8.	Tilapia 2		Present	Fiber
9.	Tilapia 3		Present	Fiber
10	Milkfish 1		Present	Fiber
11.	Milkfish 2		Present	Fiber
12.	Milkfish 3		Not present	-
After frying procces				
1.	Tilapia 1	Muscle Tissue	Present	Fiber
2.	Tilapia 2		Present	Fiber
3.	Tilapia 3		Present	Fiber
4.	Milkfish 1		Present	Fragment
5.	Milkfish 2		Present	Fragment and fiber
6.	Milkfish 3		Present	Fiber

Type and Morphologies of Microplastic

According to the FAO classification as cited in Lusher et al., (2020), Fibers and Fragments were the two most commonly found morphologies of microplastics in aquatic environments. The visual evidence of microplastic particles observed in tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) samples sold at Benowo Market can be seen in the image below :



Microplatic Morphologies Observed in the Muscle and Digestive organs of milkfish and tilapia sold at Benowo Market: a) Fiber; b) Fiber; (c) Fragment; d) Fiber

Microplastic Content in Tilapia and Milkfish

This study showed that microplastics were present in some of the tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) samples. Microplastics were identified in the digestive organs and partially in the muscle tissues. After the frying process, microplastics remained detectable in all fish muscle samples. The presence of microplastics in the muscle tissues after frying indicated that these particles were not confined to the digestive tract but had also reached the muscle tissue.

Microplastics entered the fish body through two primary pathways: oral ingestion and respiration via the gills. Once inside the digestive tract or gills, microplastic particles smaller than 5 mm could penetrate the mucosal epithelial layer through several biological mechanisms, such as endocytosis by epithelial cells, paracellular diffusion (through intercellular spaces), or due to mucosal damage caused by chronic irritation from the particles. Microplastics that successfully passed through the mucosal barrier entered the circulatory or lymphatic system, subsequently being distributed to various organs, including the liver, kidneys, and muscle tissues. Fibers with a high length-to-width ratio were more likely to infiltrate tissues due to their flexibility and shape, which facilitated intercellular penetration (Hossain, 2024).

The frying process at high temperatures (170–190°C) was not sufficient to degrade or eliminate microplastic particles. Heating during frying could alter the shape and size of microplastics, such as partial melting or shrinkage of the particles (Eshun & Pobee, 2022). The present study found that one tilapia sample that initially showed no microplastic contamination prior to frying was later found to contain fiber-shaped microplastics in the muscle after frying. This condition was likely due to the uneven distribution of microplastics within the fish body, which may be influenced by physiological differences among organs in absorbing, retaining, and distributing microplastic particles. Factors such as blood flow and metabolic activity played a role in this variability (Kim et al., 2021). Reported that microplastics could accumulate in various fish tissues, including the intestines, gills, and muscles, with distribution patterns being significantly influenced by particle size, exposure dose, duration of contact, and the species of the organism exposed.

The alteration of microplastic structure due to heating processes raised concerns that these particles might persist within fish tissues until consumed by humans. This condition opened the possibility for microplastics to enter the food chain, potentially leading to long-term health impacts on the population. The accumulation of microplastics in the human body had the potential to disrupt the function of vital organs, such as the liver and kidneys, and could cause toxicity, particularly when exposure resulted from continuous consumption of contaminated fish (Tuhumury & Ritonga, 2020).

The study by Eshun et al., (2022) stated that microplastic fibers are resistant to heat, and therefore can still be detected even after the frying process. This issue indicates that microplastic pollution is a serious problem that affects not only ecosystems but also food safety.

Form of Microplastics

The identification results showed that the microplastics found in tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) sold at Benowo Market were in the form of fibers and fragments. Fibers were more frequently observed than fragments, both in the digestive organs and in the muscle tissues, including after the frying process. One sample of milkfish that initially contained fiber-shaped microplastics prior to frying was found to contain both fibers and fragments after frying. This condition may be attributed to the melting or breakdown of fiber-shaped microplastics into smaller fragments due to exposure to high frying temperatures. These findings indicated that fibers exhibited high thermal resistance, allowing them to persist despite exposure to heat treatment (Eshun & Pobee, 2022).

Hossain, (2024) reported that very small microplastic particles (20 µm) could penetrate the epithelial mucosal layer of the intestines or gills and enter the circulatory or lymphatic system. Once inside, microplastic particles could be distributed to various fish tissues, including muscle tissue. Their study identified 132 microplastic particles in Silonia silondia, with an average of 7.40 ± 4.12 particles found in the digestive tract, 3.20 ± 1.69 particles in the gills, and 2.60 ± 1.65 particles in the muscle tissues.

Fibers were the most frequently found form of microplastics. These particles are presumed to originate from synthetic textile fibers such as polyester (PET), nylon (polyamide), and acrylic. Fibers typically enter aquatic environments through activities such as laundry discharge, the use of synthetic ropes in aquaculture, and fishing nets. Due to their flexible, lightweight, and elongated structure, fibers tend to remain suspended in the water column and are more easily ingested by fish during feeding activities (Lusher et al., 2020).

Fragments are small, irregularly shaped pieces of hard plastic. These fragments originated from the degradation of plastic polymers such as polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polystyrene (PS), which are commonly derived from beverage bottles, plastic bags, food containers, and household packaging (Hypertension & Systematic, 2024). These fragments tended to settle at the bottom of aquatic environments and were ingested by fish while foraging through substrates or filtering food particles from pond sediments. This condition indicated that the microplastic contamination found in edible fish likely originated from land-based human activities, particularly due to inefficient waste management systems surrounding the Benowo landfill site.

A similar study by Wardoyo et al., (2024) identified microplastics in the form of fibers, filaments, fragments, and granules in Tubifex worms from the Brantas River, where fibers and filaments were the most dominant forms. Their findings suggested that fibers may have originated from domestic activities such as laundry, while filaments and fragments were likely derived from plastic bags, discarded bottles, and other inorganic solid waste.

Lusher et al. (2020) also stated that fibers and fragments were the most commonly encountered microplastic types in brackish and freshwater ecosystems (Lusher et al., 2020). Due to their small size and low mass, these particles remained suspended in the water column, making them easily ingested by fish while filtering plankton or consuming other suspended food particles.

The presence of fiber- and fragment-shaped microplastics in mujair and bandeng sold at Benowo Market indicated a considerable level of aquatic environmental contamination, particularly from land-based plastic pollution originating from anthropogenic activities and suboptimal waste management systems.

Impacts and Hazard of Microplastics

The presence of microplastics in fish bodies not only raised concerns regarding the health of aquatic biota but also posed serious risks to human health as the final consumers. Microplastics entered the fish's body through feeding activities in polluted waters and could accumulate in digestive organs and, under certain conditions, translocate to muscle tissues. This process, known as Translocation, referred to the movement of microplastic particles from the intestines or gills into the circulatory or lymphatic systems, allowing them to spread to other organs (Hossain, 2024).

The study by Rofiq et al. (2022) reported that microplastics in fish could cause physical damage, such as lesions on the intestinal walls, impaired nutrient absorption, and alterations in tissue structure. Fish exposed to microplastics over extended periods exhibited signs of malnutrition, weight loss, and stunted growth (Rofiq & Sari, 2022). Furthermore, microplastics were capable of carrying hazardous pollutants such as heavy metals, pesticides, and other toxic organic compounds.

Microplastics found in the bodies of Oreochromis mossambicus and Chanos chanos posed negative impacts on both aquatic organisms and humans consuming the contaminated fish. These microscopic particles could be ingested by fish either directly or through the food chain, due to their minute size (Yona et al., 2020). Microplastics are recognized as toxic contaminants capable of inducing oxidative stress, inflammation, and increased absorption of harmful substances within the body. Several studies have revealed that microplastic exposure may lead to metabolic disorders, neurotoxicity, and heightened cancer risk. Additionally, microplastics have been associated with immunological dysfunction, carcinogenic effects, and disturbances in reproductive functions (Hanif et al., 2021).

Microplastics were capable of carrying hazardous chemical compounds adsorbed onto their surfaces, such as pesticides and heavy metals. These substances could disrupt hormonal functions, suppress the immune system, and increase the risk of degenerative diseases, including cancer (Dewi, 2022). Microplastics could enter the human body through three primary routes: ingestion, inhalation, and dermal exposure (Budiarti, 2021). The highest exposure occurred through the digestive tract, where microplastic particles larger than 130 μm were able to penetrate the epithelial lining of intestinal villi and disseminate to other tissues via the lymphatic vessels, potentially accumulating in vital organs such as the liver, muscles, and brain.

CONCLUSION

This study demonstrated that tilapia (Oreochromis mossambicus) and milkfish (Chanos chanos) sold at Benowo Market, Surabaya, contained microplastics. Prior to frying, microplastics were detected in 100% of digestive organs and in 66.7% of muscle tissues. After frying, microplastics were found in 100% of the muscle tissues. This condition was likely due to the melting of fiber-shaped microplastics into smaller fragments under high frying temperatures, explaining the persistent detection of microplastics in cooked fish and even changes in the number or morphology of particles. As a result, some microplastics that were initially undetectable could appear after thermal treatment. The types of microplastics identified consisted of fibers and fragments. Fiber-shaped microplastics were predominantly found in tilapia, whereas fragment-shaped microplastics were more frequently observed in milkfish.

These findings suggested that species-specific biological factors might influence the type of microplastics accumulated in fish tissues. Ingested microplastics have the potential to cause physiological disturbances in fish, including internal organ damage, digestive system impairment, reduced appetite, oxidative stress, and reproductive dysfunction. Furthermore, prolonged human consumption of microplastic-contaminated fish may pose risks of metabolic disorders, hormonal imbalances, immune suppression, and increased likelihood of chronic diseases and cancer. This study had limitations in identifying the polymer types of microplastics, as no advanced spectroscopic techniques such as Fourier Transform Infrared (FTIR) or Gas Chromatography–Mass Spectrometry (GC-

MS) were applied. Additionally, future studies should explore other cooking methods besides frying, such as dry heating using ovens or microwave treatment, to assess the thermal stability of microplastics without the influence of external media.

REFERENCES

Aliyansyah, G., & Holil, K. (2024). Identification of Microplastics in the Gills and Digestive Tract of Milkfish (Chanos chanos) from Traditional Ponds in Sedati District, Sidoarjo Regency. *Al-Kauniyah J. Biol*, *17*(2), 395–405,. https://doi.org/10.15408/kauniyah.v17i2.33861.

Budiarti, E. C. (2021). Identification of Microplastics in Human Feces. *Approximately. Pollute. J*, *1*, 87–88,. https://journalecoton.id/index.php/epj

Buwono, A. (2021). *Enrichment of Mother Feed to Increase the Spawning Yield of Milkfish (Chanos chanos Forsskal*. Lampung State Polytechnic.

Dewi, N. M. N. B. S. (2022). Literature Study of the Impact of Microplastics on the Environment. *Sos.Science and Technology*, *2*(2), 239–250,.

Eshun, F., & Pobee, A. N. A. (2022). Effects of frying on microplastics load in fish and implications on health. *Food Front*, *3*(4), 543–549,. https://doi.org/10.1002/fft2.164.

Hanif, K. H., Suprijanto, J., & Pratikto, I. (2021). Identification of Microplastics in the Mouth of the Kendal River, Kendal Regency. *J. Mar. Res*, *10*(1), 1–6,.

Hossain, M. B. (2024). Accumulation, tissue distribution, health hazard of microplastics in a commercially important cat fish, Silonia silondia from a tropical large-scale estuary. *Front. Sustain. Food Syst*, *8*(March), 1–12,. https://doi.org/10.3389/fsufs.2024.1372059.

Hypertension, M., & Systematic, T. (2024). Implementation and Impact of Interprofessional Education (IPE. *On "Implementation and Impact of Interprofessional Education (IPE) on Hypertension Management: A Systematic Review"," No*.

Ilmiawati, L. E. M., Aliska, G., Rustam, E., Katar, Y., Rahmatini, J., & Usman, E. (2022). Warta Pengabdian Andalas. *J. Ilm. Pengemb. and Application of Science and Technology*, *29*(3).

Kim, J.-H., Yu, Y.-B., & Choi, J.-H. (2021). Toxic effects on bioaccumulation, hematological parameters, oxidative stress, immune responses and neurotoxicity in fish exposed to microplastics: A review. *J. Hazard. Mater*, *413*, 125423.

Lusher, A., Welden, N. A., Sobral, P., & Cole, M. (2020). Sampling, isolating and identifying microplastics ingested by fish and invertebrates. In *Analysis of nanoplastics and microplastics in food* (pp. 119–148). Crc Press.

Moko, E. M., Rattu, F. E., Sakul, E. H., Naharia, O., Yalindua, A., & Rawung, L. D. (2021). Survival of Mujair Fish Seeds (Oreochromis mossambicus) and Environmental Chemical Parameter Values in Biofloc Maintenance Media with Daluga Debris as a Carbon Source. *Fuller. J. Chem*, *6*(1), 46–53,.

Nirmalasari, R. (2021). Utilization of Plastic Waste Using the Ecobrick Method in Luwuk Kanan Village. *J. Solma*, *10*(3), 469–477,. https://doi.org/10.22236/solma.v10i3.7905.

Permatasari, D. R., & Radityaningrum, A. D. (2020). Study on the Presence of Microplastics in Aquatic Areas. *Proceedings of the National Seminar on Applied Science and Technology*, 8 499–506.

Rofiq, R. A. A., & Sari, I. I. K. (2022). Microplastic Analysis in the Digestive Tract and Fish Gills in Brantas, East Java. *Approximately. Pollute. J*, *2*(1).

Sustainability, B. (2024). Utilization of Plastic Waste Through Ecobricks

Innovation in West SetiaTawar Village. *J. Servant. Mass. Nusant*, *4*(2), 106–112,.

Tuhumury, N., & Ritonga, A. (2020). Identification of the presence and type of microplastics in blood shellfish (Anadara granosa) in the waters of Tanjung Tiram, Ambon Bay. *Trit. J. Manaj. Sourced. Water*, *16*(1), 1–7,.

Wardoyo, I. R. E., Yunior, Y., Marlik, M., Kriswandana, F., Nurmayanti, D., & Khambali, K. (2024). Microplastics on Silkworms (Tubifex Spp) in the Brantas River, Indonesia. *Pollution*, *10*(1), 414–425,. https://doi.org/10.22059/Poll.2023.364979.2058.

Yona, D., Maharani, M. D., Cordova, M. R., Elvania, Y., & Dharmawan, I. W. E. (2020). Analysis of microplastics in the gills and digestive tract of reef fish in three small and outermost islands of Papua, Indonesia: preliminary studies. *J. Science and Technology. Marine. Too Much*, *12*(2), 495–505,.