# Risk Analysis of Microplastic in Fish (*Nemiptus Japonicas & Rastrelliger Sp.)* in Communities in the Coast Area of Tamasaju, Galesong Takalar

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## Abstract

Plastic waste has become one of the most serious threats to the marine environment. Among the plastic waste of special concern is microplastic because of its small size. This study aimed to analyze the level of risk of microplastic exposure through fish consumption in communities in the coastal area of Tamasaju Village, North Galesong District, Takalar Regency. Microplastic abundance found as many as 18 particles, microplastic types found are the shape of a line or fiber with different color and size variations. Blue fiber dominates at 77.77%. The average microplastic concentration (C) in fish is 0.2 mg/kg. The respondents interviewed were 30 people and mostly fishermen. Average intake rate (R) ± 155 grams/day, Average frequency of exposure (FE) of fish consumption ± 190 days/year, Average duration of exposure (Dt) of fish consumption ± 39 years and. Average respondent's weight (Wb) ± 58 kg. The average Non-Carcinogenic Intake Rate in fish consumption is 0.004754 mg/kg/day and the average Carcinogenic Intake Rate in fish consumption is 0.009328 mg/kg/day. The results of calculations with one-way ANOVA obtained P-Value = 0.009867 <value α = 0.05, then there is a strong relationship with microplastic concentration, intake rate, frequency of exposure, and duration of exposure to Intake Rate or Risk (RQ).

***Keywords:*** *Risk Analysis, Microplastic, Coastal Areas, Fish.*

## Introduction

Plastic has become a part of everyday life, from clothing to coatings and vehicles to cleaning products. So that the losses caused by the abundance of plastic waste are very visible in the environment. A particular concern among plastic waste is microplastics due to their small size[1,2]. Microplastics are defined as small pieces of plastic smaller than five millimeters in size [3–5]

Globally, the discharge of primary microplastics into the sea is estimated at 1.5 million/year[3]. Most of the microplastics come from a land that enters the marine environment, including those flowing through rivers[6,7]. Microplastics have been found in drinking water, bottled water ranges from 0 to more than 104 particles/ltr with an average value of 103 particles/ltr[8].

The consumption of microplastics by fish is closely related to plastic pollution in the marine environment[2,9,10]. Microplastics digested by fish are dominated by microplastics that are < 1 mm in size, film-like shaped,and transparent in color[11,12]. Also, microplastic particles are found in sediments and filter-feeding animals [13].

In Indonesia, plastic waste pollution has reached serious limits, according to Jambeck et al. (2015) Indonesia occupied 2nd rank as a country that produces vast plastic waste[14]. Indonesia contributes 0.48 - 1.29 million metric tons of plastic waste to the sea every year.

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Thus, in Indonesia, total plastic waste is predicted to reach 9.52 million tonnes in 2019 [15]. The identification of microplastics in the Makassar region has not found any alarming cases, including their effects on humans[16–19] However, research, as conducted by Rochman (2015) at TPI Paotere Makassar, showed quite high results, namely the number of particles in each fish ranged from 0 – 21 particles/individual[20].

One of the famous auction place of fish in Makassar is Beba North Galesong in Takalar district. Various types of seafood are traded at this auction[21,22], even visitors or buyers who come can directly enjoy the catch of fishermen which are provided in food stalls along the entrance to Beba auction place of fish, Tamasaju village, including a village that is very close to Beba auction place of fish. In this village, people have the main profession as fishermen, and most of the people here use seafood as their daily side dish.

The presence of microplastics in marine species that are often consumed by the people raises concerns about the level of risk of microplastics to human health. Therefore, in this study, we will examine the evidence of seafood contamination (fishes) by microplastics, and the level of risk from the presence of microplastics in the marine environment to human health.

## Methodology

**Type of Research:** The type of research is descriptive analysis with the Environmental Health Risk Analysis approach, by using questionnaires, interviews, laboratory examinations, and calculations using its formula. This research will be conducted in May-June 2020. Fish samples were taken for 1 day at 06.00 - 07.00 a.mon June 25, 2020, at the Bebaauction place of fish. Fish samples were taken by random sampling, namely as many as 20 fish, 10 each of red curisi, and 10 mackerel. Furthermore, fish samples are stored in a coolbox and taken to the laboratory for analysis.

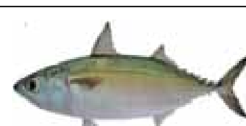
**Laboratory analysis:** Microplastic analysis consists of several stages [20]. These stages are sample preparation, dissolve organic matter with KOH% solution, microplastic observation with a microscope, microplastic measurement using *ImageJ* software. The fish sample is dissected and separated from the intestine. The fish intestines are broken and then placed into the sample to extract plastic debris from the fish intestines. Each sample pot containing 10 grams of fish intestine was filled with 20% (20-50 ml) KOH (*Potassium Hydroxide*) solution up to 3 times the volume of tissue in ultrapure water and incubated for 7 days at room temperature to digest organic matter. For each sample, the digested material was carefully sorted and examined under the euromax nexius zoom trinocular microscope.

**Statistical Analysis** The statistical analysis method used in this research is a descriptive statistical test and one-way ANOVA.

## Results Dan Discussion

**Microplastic Identification in Fish:** The fish found based on the respondent's consumption map were red kurisi fish (*Nemiptus japonicas*) and mackerel fish (*rastrelliger* sp.). Red kurisifish is demersal fish most often consumed by almost all coastal fishing families in Tamasaju village. Meanwhile, mackerel fish is pelagic fish which is also the favorite fish of the coastal residents of Tamasaju village, besides the price is very cheap it is also because the texture of this fish meat is very tasty after being processed.

**Table 1. Types of microplastic-identified fishes**

| No | Names of species | Identification of fishes in reference | Type of fishes found |
|---|---|---|---|
| 1 | Demersal fish: red kurisi fish (*Nemiptus japonicas*) |  **Source:** [23] |  |
| 2. | Pelagic fish: mackerel fish (*rastrelliger sp.*). |  **Source:** [23] |  |

The identification result of microplastics in red kurisi fish is shown in the table below.

**Table 2. Analysis result of microplastic in red kurisi fish**

<table>
<tr><th rowspan="3">No</th><th rowspan="3" colspan="2">Code of sample</th><th colspan="5">Parameter</th><th rowspan="3">Rearing</th></tr>
<tr><th colspan="4">Microplastic</th><th rowspan="2">Abund (M/I)</th></tr>
<tr><th>Shape</th><th>Color</th><th>Size (mm)</th><th>Weight (gram)</th></tr>
<tr><td>1</td><td rowspan="17">D (Red kurisi fish) Nemiptus japonicas (Bleeker, 1851)</td><td>Blanko D</td><td>-</td><td>-</td><td>-</td><td>-</td><td>0</td><td></td></tr>
<tr><td>2</td><td>D1</td><td>Line</td><td>Blue</td><td>1,394</td><td>0,0001</td><td>1</td><td>4.5</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">D2</td><td>Line</td><td>Blue</td><td>0,678</td><td>0,0004</td><td rowspan="2">2</td><td>4.5</td></tr>
<tr><td>Line</td><td>Blue</td><td>1,317</td><td>0,0002</td><td>4.5</td></tr>
<tr><td>4</td><td>D3</td><td>-</td><td>-</td><td>-</td><td></td><td>0</td><td></td></tr>
<tr><td>5</td><td>D4</td><td>-</td><td>-</td><td>-</td><td></td><td>0</td><td></td></tr>
<tr><td>6</td><td>D5</td><td>-</td><td>-</td><td>-</td><td></td><td>0</td><td></td></tr>
<tr><td rowspan="4">7</td><td rowspan="4">D6</td><td>Line</td><td>Mix</td><td>1,401</td><td>0,0001</td><td rowspan="4">4</td><td>4.5</td></tr>
<tr><td>Line</td><td>Blue</td><td>1,152</td><td>0,0001</td><td>4.5</td></tr>
<tr><td>Line</td><td>Blue</td><td>1,365</td><td>0,0000</td><td>4.5</td></tr>
<tr><td>Line</td><td>Blue</td><td>2,505</td><td>0,0005</td><td>4.5</td></tr>
<tr><td>8</td><td>D7</td><td>-</td><td>-</td><td>-</td><td></td><td>0</td><td></td></tr>
<tr><td>9</td><td>D8</td><td>-</td><td>-</td><td>-</td><td></td><td>0</td><td></td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">D9</td><td>Line</td><td>Purple</td><td>1,721</td><td>0,0001</td><td rowspan="3">3</td><td>4.5</td></tr>
<tr><td>Line</td><td>Blue</td><td>2,168</td><td>0,0001</td><td>4.5</td></tr>
<tr><td>Line</td><td>Green</td><td>1,327</td><td>0,0003</td><td>4.5</td></tr>
<tr><td>11</td><td>D10</td><td>Line</td><td>Blue</td><td>0,68</td><td>0,0002</td><td>1</td><td>4.5</td></tr>
</table>

Microplastic content was only found in samples D1, D2, D6, D9, and D10 as shown in Table 2. Total microplastics found in red kurisi fish were 11 particles. Generally, the types of microplastics found are line-shaped microplastics, consisting of blue, mix, purple, and green colors[24]. The largest microplastic size of 2.168 mm is found in sample D9 in the form of blue lines, and the smallest microplastic size of 0.68 mm is found in sample D10 in the form of a blue line. The largest abundance of microplastics was found in sample D6, namely 4 microplastics/individual, and the smallest abundance of microplastics was found in samples D1 and D10, namely 1 microplastic/individual. While, samples D3, D4, D5, D7, D8 were not found to contain microplastics.

The identification result of microplastic in mackerel fish is shown in the table below.

**Table 3. Analysis result of microplastic in mackerel fish**

| No | Code of sample | | Parameter | | | | | Rearing |
|---|---|---|---|---|---|---|---|---|
| | | | Microplastic | | | | Abund (M/I) | |
| | | | Shape | Color | Size (mm) | Weight (gram) | | |
| 1 | P | Blanko P | - | - | - | | 0 | |
| 2 | Rastrelligerbracysoma | P1 | Line | Blue | 3,122 | 0,0004 | 1 | 4.5 |
| 3 | | P2 | Line | Blue | 0,713 | 0,0001 | 2 | 4.5 |
| | | | Line | Blue | 0,921 | 0,0001 | | 4.5 |
| 4 | | P3 | Line | Blue | 3,584 | 0,0003 | 2 | 4.5 |
| | | | Line | Mix | 2,08 | 0,0004 | | 4.5 |
| 5 | | P4 | - | - | - | | 0 | |
| 6 | | P5 | - | - | - | | 0 | |
| 7 | | P6 | Line | Blue | 2,03 | 0,0001 | 2 | 4.5 |
| | | | Line | Blue | 0,926 | 0,0001 | | 4.5 |
| 8 | | P7 | - | - | - | | 0 | |
| 9 | | P8 | - | - | - | | 0 | |
| 10 | | P9 | - | - | - | | 0 | |
| 11 | | P10 | - | - | - | | 0 | |

Microplastic content was only found in samples P1, P2, P3, and P6 as shown in Table 3. The total microplastics found in mackerel fish were 7 particles. Generally, the types of microplastics found are line-shape microplastics, which consist of blue and mix colors. The largest microplastic size of 3.854 mm was found in the P3 sample in the form of a blue line, and the smallest microplastic size of 0.713 mm was found in the P2 sample in the form of a blue line. The abundance of microplastics in samples P2, P3, and P6 is 2 microplastics/individual and the abundance of microplastics is 1 microplastic/individual in sample P1. Meanwhile, samples of P4, P5, P7, P8, P9, and P10 were not found to contain microplastic.

**Microplastic Abundance of Fishes:** Generally, the type of microplastic found was line-shaped microplastic, consist of blue, mix, purple, and green colors.

Table 4 shows the shape of microplastic found in the fish's body is generally line and fiber-shaped. Meanwhile, the most dominant of amount color is blue as many 77.77%.

**Table 4. The proportion of microplastic found in fishes by shape and color**

| No | Shape | Color | Total | % |
|---|---|---|---|---|
| 1 | Line | Blue | 14 | 77.77% |
| | | Mix | 2 | 11.11% |
| | | Purple | 1 | 5.50% |
| | | Green | 1 | 5.50% |
| | **Total Particle** | | **18** | **100%** |

**Risk Analysis of MPs Exposure to Human:** The step of EHRA is a risk characteristic that conducted to determine the risk or one other hand to determine whether the risk agentsat a certain concentration of EHRA by the Directorate General of PP and PL, the Ministry of Health[25] and relevant study about health risk assessment [26] were analyzed for risky EHRA arise health disturbance by the communities or not. Risk analysis of microplastic exposure for humans refers to the guideline book.

**The Calculation of Ingestion Path Intake Rate**

The following is the calculation result of *Intake rate* through ingestion exposure (digested):

**Table 5. The calculation result of non-carcinogenic and carcinogenic intake rate**

| No. | Code of Resp. | C mg/kg | R kg/day | FE day/yr | Dt years | Wb kg | I Non-Carc | I Carc |
|---|---|---|---|---|---|---|---|---|
| 1 | SA1 | 2.5 | 0.08 | 208 | 60 | 50 | 0.005 | 0.002 |
| 2 | SA2 | 2.5 | 0.16 | 156 | 30 | 50 | 0.003 | 0.001 |
| 3 | SA3 | 5 | 0.08 | 208 | 22 | 60 | 0.003 | 0.001 |
| 4 | SA4 | 2.5 | 0.16 | 156 | 45 | 62 | 0.004 | 0.002 |
| 5 | SA5 | 2.5 | 0.16 | 208 | 20 | 60 | 0.003 | 0.001 |
| 6 | SA6 | 1 | 0.2 | 156 | 44 | 85 | 0.001 | 0.001 |
| 7 | SA7 | 4 | 0.1 | 208 | 21 | 45 | 0.004 | 0.002 |
| 8 | SA8 | 5 | 0.08 | 208 | 45 | 52 | 0.007 | 0.003 |
| 9 | BB1 | 2.5 | 0.24 | 208 | 37 | 60 | 0.007 | 0.003 |
| 10 | BB2 | 2.5 | 0.16 | 156 | 50 | 70 | 0.004 | 0.002 |
| 11 | BB3 | 2.5 | 0.16 | 260 | 20 | 65 | 0.003 | 0.001 |
| 12 | BB4 | 2.5 | 0.16 | 208 | 55 | 63 | 0.007 | 0.003 |
| 13 | BB5 | 1.25 | 0.32 | 208 | 40 | 60 | 0.005 | 0.002 |
| 14 | BB6 | 2.5 | 0.16 | 208 | 55 | 45 | 0.009 | 0.004 |
| 15 | BB7 | 2.5 | 0.16 | 208 | 60 | 50 | 0.009 | 0.004 |
| 16 | CA1 | 3.33 | 0.12 | 260 | 36 | 60 | 0.006 | 0.002 |
| 17 | CA2 | 5 | 0.08 | 260 | 45 | 65 | 0.007 | 0.003 |
| 18 | CA3 | 2 | 0.1 | 208 | 42 | 45 | 0.004 | 0.002 |
| 19 | CA4 | 2.5 | 0.24 | 208 | 48 | 72 | 0.008 | 0.003 |
| 20 | CA5 | 2.5 | 0.16 | 260 | 40 | 50 | 0.008 | 0.003 |
| 21 | CA6 | 5 | 0.08 | 260 | 55 | 56 | 0.009 | 0.004 |
| 22 | CA7 | 2.5 | 0.16 | 156 | 36 | 62 | 0.003 | 0.001 |
| 23 | CA8 | 1.25 | 0.32 | 156 | 46 | 62 | 0.004 | 0.002 |
| 24 | BC1 | 2 | 0.2 | 156 | 10 | 50 | 0.001 | 0.000 |
| 25 | BC2 | 10 | 0.04 | 156 | 57 | 38 | 0.009 | 0.004 |

Table 5 shows that the mean body weight of respondents is ± 58 kg, with the lowest body weight in the BC2 sample, namely 38 kg, and the highest body weight in the SA6 sample, namely 85 kg. The average intake rate is ± 155 grams/day of processed dry weight, where the minimum intake rate value is 40 grams/day in the BC2 sample and the maximum intake rate value is 320 grams/day in the BB5 and the CA8 samples. Generally, fish consumption by respondents is 1-2 fish/day and 6 fish/week. The average frequency of exposure to fish consumption of ± 190 days/year with a minimum frequency of exposure of 104 days/year is found in the BC4 and the BC5 samples and the maximum value of frequency of exposure 260 days/year are found in BB3, CA1, CA2, CA5, and CA6 samples. The average duration of exposure to fish consumption was ± 39 years with a minimum exposure duration value of 10 years in BC 1 and BC 7 samples, and the maximum duration of exposure was 60 years in SA1 and BB7 samples.

Based on the above tables is obtained the calculation result of the intake rate for respondents both carcinogenic and non-carcinogenic. If the intake rate <RfD (Reference Dose) then it is safe, otherwise if the intake rate >RfD (Reference Dose) then it is not safe. Meanwhile, RfD of microplastic is not yet determined by EPA, then the first RfD microplastic must be found by using the derivation of NOEL's formula.

**Table 6. Result of carcinogenic and non-carcinogenic intake rate**

| I Non Carcinogenic | | I Carcinogenic | |
|---|---|---|---|
| Mean | 0.004754 | Mean | 0.002037599 |
| Median | 0.004103 | Median | 0.001758547 |
| Mode | 0.003546 | Mode | 0.001519635 |
| Standard Deviation | 0.002549 | Standard Deviation | 0.001092592 |
| Range | 0.008378 | Range | 0.003590718 |
| Minimum | 0.00095 | Minimum | 0.000407045 |
| Maximum | 0.009328 | Maximum | 0.003997763 |
| Sum | 0.142632 | Sum | 0.061127963 |
| Count | 30 | Count | 30 |

The table above shows that deviation standard I-non carcinogenic = 0,002549 <mean=0,004754. The minimum value of *Intake Rate* Non Carcinogenic= 0.00095 found in BC7 sample, and the maximum value of *Intake Rate Carsinogenic* = 0.009328 found in CA6 sample. Meanwhile, deviation standard I-Carsinogenic = 0,001092592 < mean = 0.002037599. The minimum value of *Intake Rate C*arsinogenic = 0,000407045 found in BC7 sample, and the maximum value of *Intake Rate* Carsinogenic = 0,003997763 found in CA6 sample.

| Anova | | | | | | |
|---|---|---|---|---|---|---|
| **Source of Variation** | **SS** | **df** | **MS** | **F** | **P-value** | **F crit** |
| Between Groups | 59.25 | 1 | 59.25 | 10.09 | 0.009 | 4.96 |
| Within Groups | 58.70 | 10 | 5.87 | | | |
| **Total** | **117.96** | **11** | | | | |

Based on the calculation by using ANOVA is obtained p-value = 0,009867 < α= 0,05, then there isa relationship with microplastic concentration, intake rate, exposure frequency, and exposure duration on *Intake Rate* or magnitude of risk (RQ).

## Conclusion

Microplastic as found in red kurisi fish *(Nemiptus japonicas)*is 11 particles, and mackerel fish (*rastrelliger sp*.) is 7 particles. Microplastic is found inthe line or fiber-shaped only. Blueline dominates other colors is 77.77%. These lines or fiber-shaped microplastic is predicted comes from the degradation of fishnets, cover tarpaulin of fisherman boat, and seat layer along the edge of the coastal of Beba, Tamasaju village.

The calculation result of Intake Rate, both non-carcinogenic and carcinogenic showed a strong relationship with the concentration (C) of microplastics in fish, intake rate (R), frequency of exposure (FE), duration of exposure, and body weight (Wb) of respondents.

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**Ethical Clearance:** Our study was not directly applied on human, hence ethical clearance was not required.

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**Conflict of Interest:** The authors have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.

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