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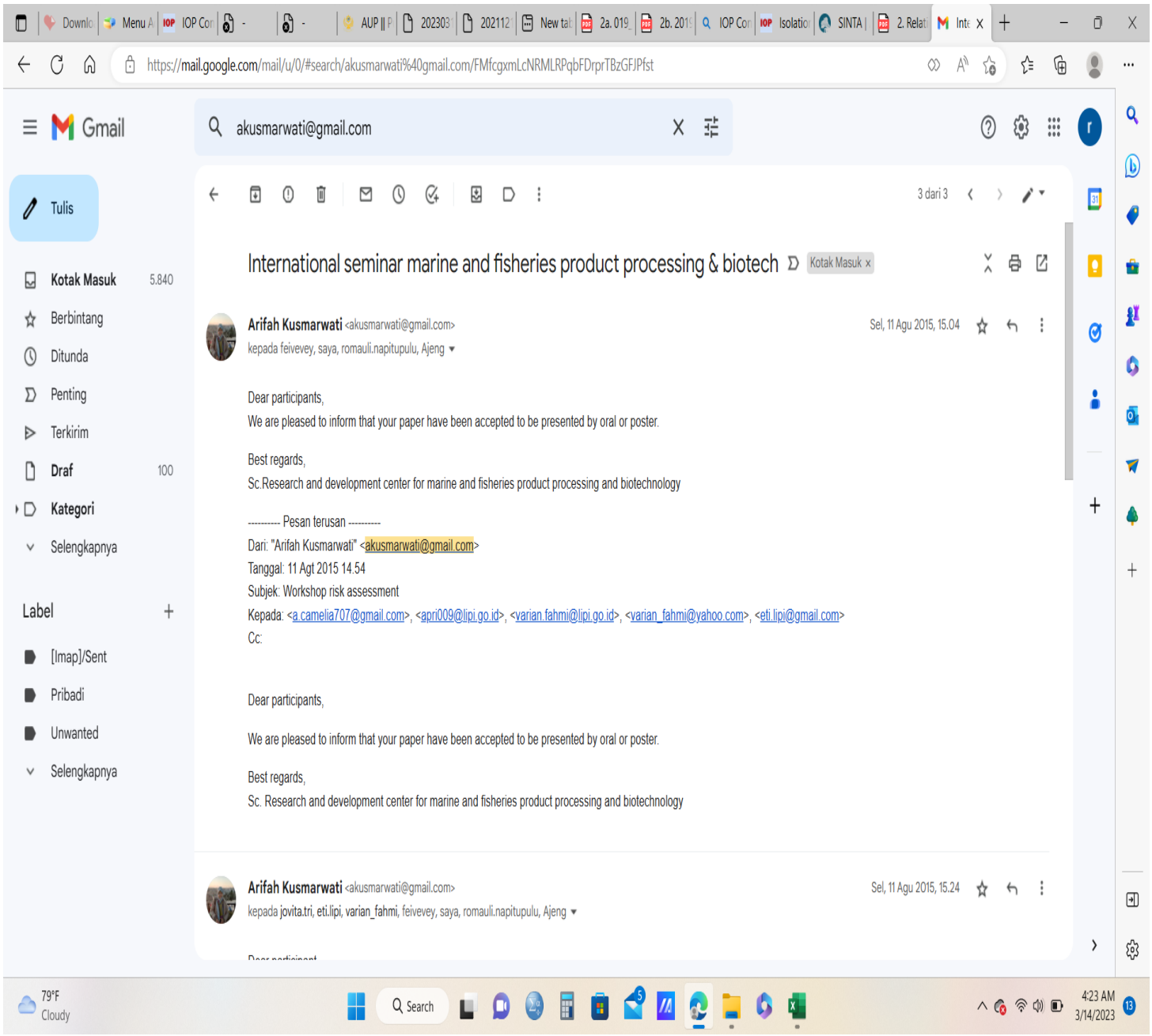

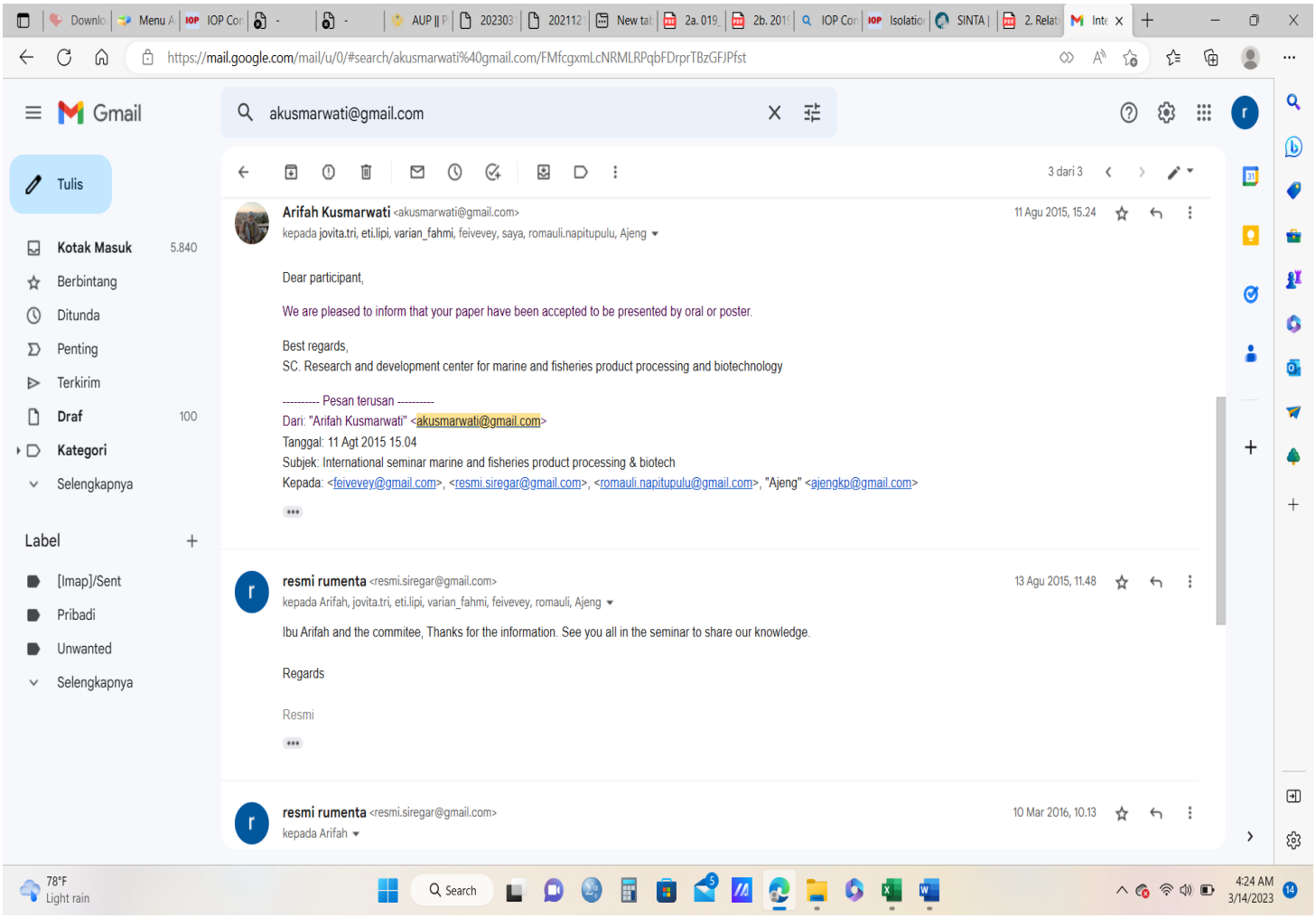
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Arifah Kusmarwati <akusmarwati@gmail.com>
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Yth. Resmi Rumenta Siregar

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Relationship Between Mercury Accumulation in Tuna (*Thunnus Sp*) With Regards to Fish Size, Species and Environments

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3) Lecturer in Sekolah Tinggi Perikanan

Abstract

This study purpose to determine the correlation between tuna weight toward the mercury content, comparing total mercury of tuna fish from the same fishing areas with different species and comparing the mercury content of tuna fish with the same species from different fishing areas. The samples are *yellowfin* tuna (*thunnus albacares*) and *bigeye* tuna (*thunnus obesus*), the weighs are range between 30-80 kg and also fishing areas of Indian Ocean and Banda Sea. Analysis of mercury content using Atomic Absorption Spectrophotometer (AAS). Data were analyzed using correlation test and T test.

The results of correlation test for *yellowfin* tuna has r value = 0,943 > r table = 0,468, and *bigeye* tuna r value = 0,802 > r table = 0,468 that meaning of the correlation is positive. From the t test results on samples *yellowfin* and *bigeye* tuna fishing areas in the Indian Ocean t value (4,036) > t table (2,037) that meaning of significant difference. From the t test results on samples *yellowfin* and *bigeye* tuna in the Banda Sea t values (3,939) > t table (2,037) that meaning of significant difference. From the results of the t test *yellowfin* tuna with the different fishing area of Indian Ocean and Banda Sea t value (3,108) > t table (2,037) that meaning of significant difference. From the results of the t test *bigeye* tuna with the different fishing areas of Indian Ocean and Banda Sea t value (2,819) > t table (2,037) that meaning of significant difference.

Keywords : Mercury, Yellowfin tuna, Bigeye tuna, fishing ground

1. Introduction

Indonesia is the country with the highest potential of tuna in the world. Total tuna production in Indonesia is about 613.575 tonnes per year and the value is about 6.3 trillion dollars per year . Indonesia became important for the global tuna fisheries both in terms of resources , habitat and also trade because of supported by 2 wide ocean, Indian Ocean and the Pacific Ocean (KKP , 2014).

Based on data from the Food and Drug Administration (FDA) United States , in 2011 there were 89 cases of rejection of tuna exports from Indonesia to the United States, because of histamin, salmonella and heavy metals (mercury/Hg, lead and cadmium/Cd). About 19.44 tonnes of tuna with economic value about US$ 128.71 million was rejected (Bisnis.com , 2013).

Haevy metals such as mercury, lead, cadmium and nickel are harmfull for every organism eventhought in small concentrations. Metals are highly persistent substances that can accumulate in the food chain and cause accumulation effect in humans (Noble , 2005). Mercury has a high ability to participate in the process of bioaccumulation in marine organisms.

In many cases , mercury bioaccumulation is continuing to follow the food chain.

Predator had higher concentrations of mercury in their flash than their prey(Mukhtasor , 2007) . It is because of the predators eat small fish and organism that lived in lower levels of water which have been contaminated by food chain.

In case of Minamata, source of mercury contamination is from a plastic factory which used vinyklorida and acetaldehyde as raw materials. The factory dumped mercury into Minamata bay and entered into Minamata River . Analisys shown that, fish from Minamata River contains 27-102 ppm of mercury (Hg). During the years 1953-1960, 111 of fishermen was poison with mercury (Soemirat , 2003).

The purpose of this study was to determine the correlation between tuna weight (30-80 kg) toward the mercury content, comparing mercury content of tuna from same fishing ground with different species (Yellowfin and Bigeye) and comparing the mercury content of tuna with the same species from different fishing ground (Indian Ocean and Banda Sea).

2. Materials and methode

2.1. Sample handling and Methode

This study was conducted on Januari-May 2015, at the PT. Seafood Inspection Laboratory and PT. Balinusa Windumas, Benoa-Bali.

Yellowfin and bigeye tuna as samples of this study took from PT. Balinusa Windumas, with weight range of 30-32 kg, 33-35 kg, 36-38 kg, 39-41 kg, 42-44 kg, 45-47 kg, 48-50 kg, 51-53 kg, 54-56 kg, 57-59 kg, 60-62 kg, 63-65 kg, 66-68 kg, 69-71 kg, 72-74 kg, 75-77 kg and 78-80 kg. Fish was catch by longline from Indian Ocean (South) and Banda Sea (Northern). Fish was directly transported to the laboratory at the same day in sterofoam with jelly ice.

Methodes of measuring total mercury use *Atomic Absorption Spectrophotometer* (AAS).

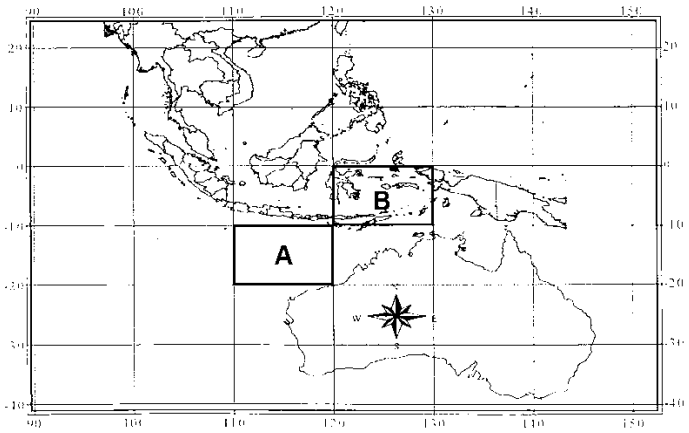


Figure 1. Fishing Ground (A is Indian Ocean, B is Banda Sea).

2.2. Data analysis

Microsoft Excel 97 was used for data processing, to calculate means and standard deviations for all multiple measurements and to generate graphs.

Pearson correlation was applied to determine relationship between weight of tuna and total of mercury in their flash. Significant differences of total mercury to weight, species and fishing ground, were determined by Two Independent sample T-test.

Pearson Correlation

$$r = \frac{n\sum X_i Y_i - \sum X_i \sum Y_i}{\sqrt{n\sum X_i^2 - \left(\sum X_i\right)^2}\sqrt{n\sum Y_i^2 - \left(\sum Y_i\right)^2}}$$

r = correlation n = number of samples

x = weight of tuna y = mercury content

Df = n – 1

Df = Degrees free

n = number of samples

r calculate < r table = not significant correlation

r calculate> r table = significant correlation

Two Independent Samples T Test

Mean = $\frac{\sum_{i-1}^{n} x_i}{n}$

$S^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n-1}$

S2 = Variants

xi = variable results

X = Average

n = number of samples

$F = \frac{S_1^{\,2}}{S_2^{\,2}}$

F = F determine

S_1^2 = biggest value of variant

S_2^2 = smallest value of variant

T test for equal variances (equal variance)

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

T test for different variances(unequal variance)

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

S_1 = standard deviation of sample 1

S_2 = standard deviation of sample 2

S_1^2 = sample variance 1

S_2^2 = sample variance 2

r = correlation between the two samples

n = number of samples

3. Result and discussion

3.1. Correlation Between Weight and Total Mercury of tuna

Mercury was analisys for *Yellowfin* dan *Bigeye* spesies for range of weight between 30-80 kg. The result of analisys shown that all sampel contain mercuri. Bigeye tuna contain mercury higher than Yellowfin in the same size. Data of mercury analisys of Yellowfin dan Bigeye spesies shown in table1.

Table1. Mercury in *Yellowfin* and *Bigeye*

No	Berat (kg)	Merkuri *yellowfin* (ppm)	Merkuri *bigeye* (ppm)
1	30-32	0,378	0,388
2	33-35	0,332	0,528
3	36-38	0,293	0,705
4	39-41	0,437	0,812
5	42-44	0,470	0,808
6	45-47	0,509	0,860
7	48-50	0,620	0,997
8	51-53	0,697	0,966
9	54-56	0,702	0,903
10	57-59	0,693	0,836
11	60-62	0,662	0,995
12	63-65	0,740	0,947
13	66-68	0,778	1,073
14	69-71	0,767	1,023
15	72-74	0,780	0,943
16	75-77	0,811	0,992
17	78-80	0,824	1,005

Correlation Spearmen was used to analysis the data in table 1 to determine if the size of tuna effect the content of mercury. Graph of correlation between mercury accumulation in tuna (yellowfin and bigeye) with regards to size shown in Figure 1..

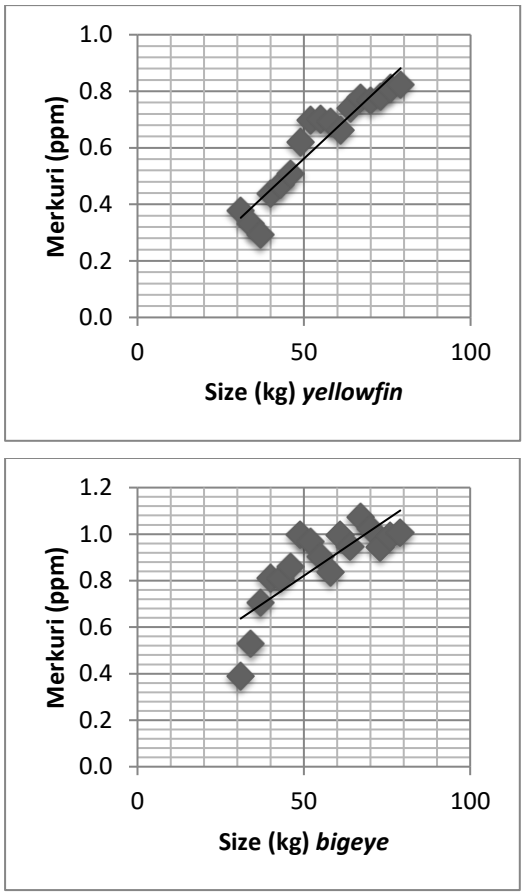


Figure 2. Correlation between mercury accumulation in tuna (yellowfin and bigeye) with regards to size.

This correlation test is to determine if the size of tuna effect the content of mercury. Correlation test shown that the yellowfin tuna species has a positive correlation with determined r value = .943> r table = 0.468, and bigeye has also a positive correlation with determinate r value = 0.802> r table = 0.468.

Correlation value of bigeye is lower than yellowfin tuna. For both species can be concluded that there were positip relationship between the weight of tuna and mercury content. The greater weight of tuna, the greater the content of mercury. This is because tuna is top level predatory, so mercury was accumuklated in their flesh more than the fish and other organism in below level of food chain.

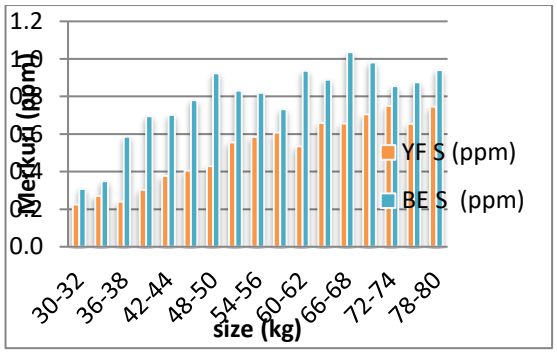
3.2. *The mercury content of yellowfin and bigeye tuna from Indian Ocean and Banda Sea*

Data of total merkuri of *yellowfin and bigeye between weight* 30 – 80 kg from Hindia Ocean, shown in table 2.

Tabel 2. Total merkuri of *yellowfin and bigeye* from Hindia Ocean,

No	Weight (kg)	*yellowfin* Samudera Hindia (ppm)	*bigeye* Samudera Hindia (ppm)
1	30-32	0,224	0,309
2	33-35	0,270	0,349
3	36-38	0,241	0,586
4	39-41	0,303	0,696
5	42-44	0,376	0,702
6	45-47	0,405	0,780
7	48-50	0,429	0,924
8	51-53	0,555	0,831
9	54-56	0,584	0,820
10	57-59	0,608	0,733
11	60-62	0,535	0,937
12	63-65	0,659	0,890
13	66-68	0,656	1,036
14	69-71	0,706	0,981
15	72-74	0,749	0,855
16	75-77	0,654	0,875
17	78-80	0,747	0,940

Graph of total mercury of yellowfin and bigeye tuna from Indian Ocean and banda Sea shown in Figure 3 .



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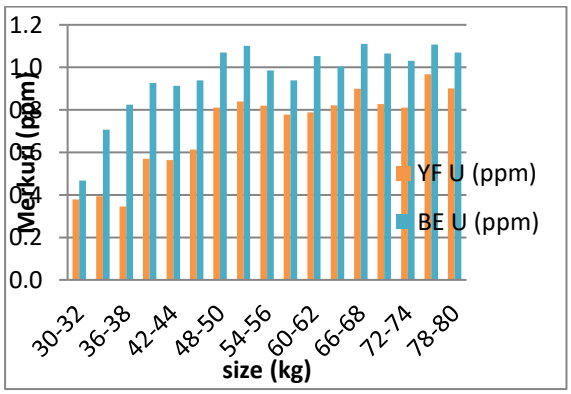


(b)

Figure 3. (a)Graph of total mercury of yellowfin and bigeye tuna from Indian Ocean, (b) Graph of total mercury of yellowfin and bigeye tuna from Banda Sea

T test performed on total mercury in yellowfin and bigeye from Indian Ocean, obtained stat t values (4.036)> t table (2.037). This shown that differences of species of tuna, yellowfin and bigeye from same fishing ground have significant differences in mercury accumulation. From the results of the t test on yellowfin and bigeye tuna from Banda Sea, obtained the t stat value (3.939)> t table (2.037). This shows that differences of tuna species, yellowfin and bigeye from the Banda Sea have significant differences in mercury accumulation.

This significant differences is cause by the differences of behavior, temperature and depth of habitat, between yellowfin and bigeye, which is affect the total of mercury.

From the results of the t test on yellowfin tuna from Indian Ocean and yellowfin from Banda Sea, obtained t stat values (3.108)> t table (2.037). This shows that, same species of tuna from different fishing ground have significant differences in mercury accumulation

3.3 . The mercury content of tuna fish species Same arrest Different Regions

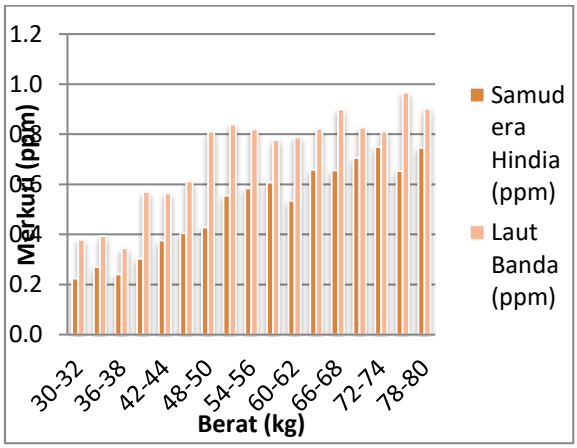
Data of total merkuri of *yellowfin weight* 30 – 80 kg from Hindia Ocean and Banda Sea, shown in table 3.

Tabel 3. Total merkuri of *yellowfin* from Hindia Ocean and Banda Sea.

No	Weight (kg)	Merkuri *yellowfin* Samudera Hindia (ppm)	Merkuri yellowfin Laut Banda (ppm)
1	30-32	0,224	0,378
2	33-35	0,270	0,393
3	36-38	0,241	0,345
4	39-41	0,303	0,570
5	42-44	0,376	0,564
6	45-47	0,405	0,613
7	48-50	0,429	0,811
8	51-53	0,555	0,839
9	54-56	0,584	0,820
10	57-59	0,608	0,778
11	60-62	0,535	0,788
12	63-65	0,659	0,821
13	66-68	0,656	0,899
14	69-71	0,706	0,827
15	72-74	0,749	0,810
16	75-77	0,654	0,967
17	78-80	0,747	0,901

Tabel 4. Total merkuri of *bigeye* from Hindia Ocean and Banda Sea

No	Berat (kg)	Merkuri *bigeye* Samudera Hindia (ppm)	Merkuri bigeye Laut Banda (ppm)
1	30-32	0,309	0,467
2	33-35	0,349	0,707
3	36-38	0,586	0,824
4	39-41	0,696	0,927
5	42-44	0,702	0,913
6	45-47	0,780	0,939
7	48-50	0,924	1,069
8	51-53	0,831	1,101
9	54-56	0,820	0,986
10	57-59	0,733	0,939
11	60-62	0,937	1,053
12	63-65	0,890	1,003
13	66-68	1,036	1,110
14	69-71	0,981	1,065
15	72-74	0,855	1,030
16	75-77	0,875	1,108
17	78-80	0,940	1,070



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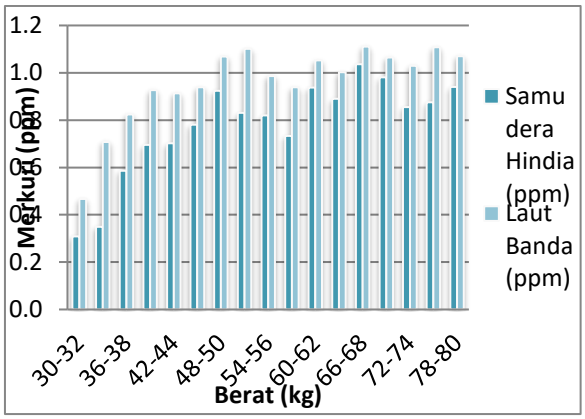

(b)

Figure 4. (a)Graph of total mercury of yellowfin and bigeye tuna from Indian Ocean, (b) Graph of total mercury of yellowfin and bigeye tuna from Banda Sea

As shown in Figure 4 (a) it can be seen that mercury of yellowfin tuna were caught at Banda Sea is higher than mercury were caught in Hindia Ocean. Yellowfin tuna were caught in Banda Sea and Hindia Ocean there are nothing who have 1 ppm as standard, according to SNI 01-2693.1-2006 about raw material of fresh tuna, it safe to consumption. Beside that, the figure k below shows that mercury contain of Tuna bigeye that caught in Banda Sea is higher than Hindia Ocean. On the charts, bigeye tuna that caught in Banda Sea (46 kg) and Hindia Ocean (66 kg) were contain more than 1 ppm mercury as

standard, according to SNI 01-2963.1-2006 about raw material of fresh tuna, it is not safe for consumption.

T-test that have done to compared the mercury contain of Tuna with the same species at different fishing area. There are between yellowfin that caught in Hindia ocean and Banda sea and also bigeye that caught in Hindia ocean and banda sea. The fishing area of yellowfin and bigeye tuna hindia ocean covering southern east Java, Bali to Nusa Tenggara, meanwhile, fishing area of yellowfin and bigeye in northern sea namely Banda sea. The result of yellowfin tuna's T-test that caught in Hindia ocean and banda sea with the weight of sample is 30 – 80 kg which grouping each multiple of three obtained T value (3,108) > T table (2,037). The result shown that different fishing area with same species of tuna have significant differences on mercury contain.

From the T-test that have done, to compared the bigeye tuna that caught in Hindia ocean and Banda sea obtained T-value (2,819) > T-table (2,037). The results shown that different fishing area with the same species of tuna have significant differences in mercury contain. Northern fishing area (Banda sea) which is surrounded by islands that can causing mercury's pollution as consequence of disposal of sewage-waste into the sea from company or housing directly. Another factor such as temperature, meeting point of some flows at the ocean, and the depth of banda sea are likely give an effect for mercury contamination in biota inside.

4. Conclusion and Recomendation

4.1 Conclusion

1) There are a relation between the weight of tuna and mercury contain. The greater weight of tuna so that the greater the levels of mercury will containing inside body and otherwise.
2) Mercury contain of yellowfin and bigeye tuna with the same fishing area have a significant defferences. Mercury contain of yellowfin tuna are smaller than bigeye tuna at the same fishing area.
3) Mercury contain of different fishing area with the same species of tuna have a significant defferences. Mercury contain of the yellowfin and bigeye tuna were caught in banda sea are bigger than Hindia ocean

4.2 Recomendation

1) The tuna fish processing company should pay attention of weight, species, and fishing area in the purchase of raw material tuna
2) Need to do research on other species of tuna

Acknowledgements

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Topics : Food safety and Environment

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EDITOR : **THS**

1.	**TITLE**	OK
2.	**ABSTRACT**	OK with slight revision
3.	**INTRODUCTION**	OK

4.	**MATERIAL AND METHODS**	**OK with addition of mercury standard analysis, data validation, extraction process**
5.	**RESULTS AND DISCUSSION**	Need a proof of data validity (standard and CRM analysis)
6.	**CONLUSSION**	Please write your conclusion in paragraf not in bullet or number.

7.	**REFERENCES**	More up to date primer references

GENERAL NOTES:

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Based on the above assessment, it was concluded that this manuscript:
1. ~~Acceptable with minor improvements~~
2. Acceptable with mayor improvements