"THE USE OF ACETIC ACID IN REDUCING MERCURY CONTENT IN DEMERSAL FISHES AT BUYAT BAY AND ITS VALUE ADDED IMPROVEMENT AS COOKIES PRODUCT"

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ABSTRACT

It has been long indicated that the community live along the coastal of Buyat Bay consume fishery products which contaminated by the attendance of heavy metal mercury which are being one element of wastes resulted from the mining industry namely PT NEWMONT MINAHASA RAYA located near to Buyat Bay. It is known that mercury is a harsh chemical compound which can affect on the function of brain system, skin irritation, and kidney disfunction. The negative impact comes from the mercury pollution in marine water, is the increase of unsafe feeling among the people to consume fishery products; and this is definitely against the national programs in improving the healthy and quality of people by increasing the fish consumption. Therefore, it is necessary to find out how to provide fish products located at contaminated waters which can be safely consumed.

The result of this research showed that the fresh flesh of Banded Grunter fish (*Ephinephelus* sp) and the flesh of Long-jawed mackerel fish (*Nemipterus* sp) caught from Buyat Bay on December 2004, naturally possessed lower mercury contents such as 0.017 ppm and 0.034 ppm than that of allowed by WHO as 0.5 ppm. The soaking of fish fleshes in 5% acetic acid for 30 minutes was able to reduce the mercury content as 61.76-64.70%; further the soaking of fish livers in 5% acetic acid for 30 minutes was able to reduce the mercury content as 77.27-88.21%.

Fish cookies was made by the equal concentration of Banded Grunter and Long-jawed mackerel fleshes and added into the formulation of cookies with three level concentrations such as 5, 10, dan 15%. Thirty panelists could accept the cookies products containing all different concentrations without any significant differences. The chemical properties of cookies containing 15% fish fleshes are followed : water 3.19%, ash 2.67%, crude protein 16.75%, crude fat 23.48%, and carbohydrate 53.89%; which is 80% higher than that of control cookies. The use of 15% fish in the formulation could increase the amount of essential amino acids as 130-380 %, mainly for lysine. Protein digestibility of cookies was about 79.32-82.96%, whereas the increase of fish concentration would also improve the protein digestibility of protein in cookies products.

Key words : mercury, Buyat Bay, acetic acid, cookies, Banded Grunter, Long-jawed Mackerel

I. INTRODUCTION

Mercury, beside of cadmium and arsenic, has ever been judged to cause some physically and nerve negative symptoms occurred among people live along the coastal of Buyat Bay and consumed fishery products which caught from marine waters surrounding. Some bruises were appeared on the surface of parts of body among the local community, and became as a controversy, they claimed these were caused by consuming water and fishery products naturally produced surrounding.

Naturally, heavy metal is being one of component in land, which can not be degraded or destroyed. This heavy metal is entered into human body through foods, drink water, or even air. Heavy metals can be considered as a dangerous element since its bioaccumulation effect in the body in line with the food pyramidal system; therefore the increase level of heavy metal within environmental will also cause the increase of heavy metal levels in the body which can not be easily extracted or degraded in the body. Mercury can cause the serious effect towards on the healthy quality of human, mainly against nerves system, skin irritation, and kidney dysfunction. The emotional disturbance caused by mercury contamination can also happened, such as high temper, tremor, shiny, disturbances in sight and memory.

In waters, mercury can be easily react with Chloride, which will react to make an inorganic mercury (HgCl). This HgCl is able to easily enter into plankton and move to other marine organisms or consumed by fishes, therefore the mercury level in fish body is high. In food chain, the bigger fish can be predator towards on other smaller fishes. This cause the highest level of mercury is possessed by the highest fish predator, which can accumulate ten folds of mercury content in waters surrounding. In human body, heavy metal will be able to replace other more useful minerals such as: Zn, Cu, Mg, and Ca.

Another more fatal effect caused by the occurrence of contaminated waters and fish products, is the excessive anxiety among the people to consume fishery products. This fact is contradiction with the national program announced by the Indonesian government in improving the healthy and the intelligence of people through increasing fish consumption in dietary pattern. With more than 1.9 ppm content of methyl mercury in fish products will be dangerous to be consumed, especially for children. In Minamata case, the content of methyl mercury in fish reached about 100 ppm. Therefore, it is important for the government to provide information about methyl mercury content in fishery products in all areas; however this is still never being done up to present time.

On the other hand, fish consumption among Indonesian people at current time is still low, maybe the lowest one among Asian countries, as approximately 24,67 kg/cap/yrs; even it is claimed that Indonesia is being the fifth fish producer country in the world. The low behavior in consuming fish among Indonesian people is presumably having a positive correlation with the low level of manpower quality as indicated in Human Development Index (HDI).

In 2002, among 173 countries counted, HDI Indonesia reached 110 (UNDP, 2002); this fact was worse than that of 2001. Among Southeast Asian countries, Indonesia reached the seventh level from 10 countries counted. This condition will, of course, have further worse implication in global competition map in the future.

Optimalization usage of fishery products through the production of value added fish products is being one of the main program in Indonesia at present time, in order to enlarge the acceptability of people towards on fishery products, beside to strengthen the national food security and to improve the cleverness of Indonesian manpower. Therefore, it is

extremely urgent to clarify contamination problems occurred in waters environmental, so that the image of fish as a safe food product can be claimed again.

Main purpose of this research was finding out the simple method in reducing the mercury level in fishery products which can be easily applied among the people by using the safe and popular chemical compound. Furthermore, the specific purposes in this research, were :

a. To result low mercury level in fishery product which can be easily and safely consumed by the community at Buyat Bay, North Sulawesi
b. To process fishery products with low content of mercury level into a value added product such as a cookies to widespread the acceptance capacity of fishery product among the people

II. METHODOLOGY

a. Sampling Activity

Kind of fishes used in this research were Banded grunter (*Ephinephelus* sp) and Long-jawed mackerel (*Nemipterus* sp). These demersal fishes were caught at the location near to the mining industrial tailing underwater in Buyat Bay with the depth approximately 10 m. Sampling activity was done on December 10 and 15, 2004. After washed carefully, fishes were stored within coolbox with appropriate crushed ice amount. Fishes, then, were kept in the freezer with temperature -20°C until analysis would be done during this experiment. Prior to be used in the experiment, fishes were degutted and filleted manually.

b. Preparation of Acetic Acid 5% as the Soaking Solution

Commercial acetic acid "DIXI" was bought in local market. This commercial acetic acid solution had 25% of acetic acid concentration, therefore it should be diluted to be 5% with water.

c. Soaking Process of Fish Flesh in 5% Acetic Acid Solution

100 g fish flesh was soaked in 200 ml 5% acetic acid solution for 30 minutes. To neutralize the acidity level of fish flesh, then it was soaked in 7% Na_2CO_3 for 60 minutes.

d. Processing of Fish Flour

Fish flesh was steamed for 10 minutes, prior to be pressed. Then, the pressed fish flesh was dried for 8 hours in oven dryer at temperature 50-55°C. Dried fish flesh was then grinded and filtered. Fish flour was ready to be used in the formulation of further end food products.

e. Processing of Fish Cookies

Banded grunter fish flour and Long-jawed mackerel flour (1 : 1) were used in the formulation of cookies with concentration 5, 10, 15% from wheat flour concentration. Other components used in the formulation were chicken egg, sugar flour, margarine, full cream milk, salt, aroma enhancer, baking powder. The dough was stored in the freezer for 3 hours, prior to be sliced with width 2-3 mm. The drying process was done by using an oven dryer with temperature 155°C for 15 minutes. The fish cookies were ready to be consumed or packaged for further distribution.

Tabel 1. Components in *Fish Cockies* Formulation

No	Components	Amount(g)
1	Wheat flour	100
2	Sugar flour	20

3	Egg	20
4	Margarine	35
5	Full cream milk	2.5
6	Baking powder	0.2
7	Aroma enhancer	1
8	Salt	1

f. Analysis in Research

Kind of analysis observed in this experiment were :

f.1. Chemically analysis : proximate (AOAC, 1984), total mercury content (AOAC, 1984), protein digestibility (AOAC, 1984), amino acid (AOAC, 1984)

f.2. Physically analysis : pH, Aw, hardness, whiteness

f.3. Consumer preference test : judged by unskilled 30 panelists towards on color, taste, crispiness, performance, flavor criterions with 7 level hedonic scales

III. RESULTS AND DISCUSSION

III.A. Geographical Location

Ratatotok Bay and Buyat Bay locate at southern coast of North Sulawesi, with position 124°41'24" – 124°44'24" East Longitude dan 0°50'24" – 0°54'00" North Latitude. Administratively, Ratatotok Bay and Buyat Bay involve in East Ratatotok Village, Ratatotok District, South Minahasa Region. Road as the transportation infrastructure has been existed, so that the transportation and communication are being easily occurred; beside of the availability of electricity. There are three piers available for fishing landing, such as Lakban, Ratatotok, and Bungan. Traditional fishing methods are done by local people in Buyat and Ratatotok Bays.

III.B. Fact of Buyat Bay

The width of Ratatotok Bay and Buyat Bay are 2,692 ha and 48,4 ha. Based on *Trapezoidal rule*, *Simpson's rule* and *Simpson's 3/8 rule* approaches used that the volume of each coast is 866.8 juta m3 for Ratatotok Bay and 24.3 juta m3 for Buyat Bay, with flushing time seawater at those Ratatotok Bay and Buyat Bay is 56 times/year or 6.5 days (BRKP DKP RI (2004)). Flushing time is the average time of the particle to stay in water's body which is identified as the moving effectivity of a pollutant so that the environmental will be cleaned. Table 2 showed the sediment characteristic at Ratatotok Bay and Buyat Bay

Tabel 2. Sediment characteristic at Ratatotok Bay and Buyat Bay

Variable	Ratatotok Bay (n = 11)	Buyat Bay (n = 9)
Texture		
- Sand (%)	34,72 ± 26,17	32,89 ± 26,67
- Ash (%)	59,45 ± 25,22	60,00 ± 23,34
pH H_2O	7,81 ± 0,19	7,72 ± 0,35
pH KCl	8,18 ± 0,21	8,23 ± 0,05
Redox	- 35 - - 17	-
Organic Material(%)	2,95 ± 2,24	2,54 ± 2,13
PO_4 (ppm)	1,01 ± 0,35	1,38 ± 0,65
P_2O_5 (ppm)	0,75 ± 0,26	1,03 ± 0,49
SO_4 (ppm)	0,27 ± 0,11	0,15 ± 0,07
Fe (ppm)	254,23 ± 395,88	261,92 ± 210,78
Al (ppm)	45,19 ± 65,86	91,94 ± 210,78

Source : BRKP DKP RI (2004)

Table 3. Water Quality of Ratatotok Bay (n = 4) dan Buyat Bay (n = 3)

Parameter	Water Surface Ratatotok	Water Bottom Ratatotok	Water Bottom Buyat
Temperature (°C)	27,13 ± 0,25	27,13 ± 0,20	26,8 ± 0,20
Salinity (ppt)	33,00 ± 1,70	34,00 ± 0,91	-
pH	8,44 ± 0,06	8,44 ± 0,06	8,30 ± 0,06
Dissolved Oxygen (ppm)	5,81 ± 0,23	5,72 ± 0,20	-
Turbidity (NTU)	4,42 ± 8,22	3,73 ± 4,66	3,73 ± 4,66
Brightness (m)	9,10 ± 2,16	-	-
TSS (ppm)	74,10 ± 30,85	74,83 ± 35,16	74,83 ± 35,16
NH_4-N (ppm)	0,43 ± 0,37	0,49 ± 0,37	0,49 ± 0,37
NO_3-N (ppm)	0,15 ± 0,19	0,14 ± 0,17	0,14 ± 0,17
PO_4-P (ppm)	0,41 ± 0,20	0,36 ± 0,12	0,36 ± 0,12

Source : BRKP DKP RI (2004)

The accumulation, mobility, and bioavailability of heavy metals in waters environmental are depending on some physical and chemical processes, such as: temperature, salinity, organic materials, pH, potential redox, chelator and surfactant, and other metals. Hart (2002) showed that enhancer value of sediment quality is 150 ppb and highly risk value is 1 000 ppb; however CEQG (2002) suggested 130 ppb and high risk value is 700 ppb. Based on that, mercury content in sediment located at Ratatotok Bay in some sampling areas, has already exceed the allowed of diminished threshold (50% dari n = 20). BRKP DKP RI (2004) showed that mercury content in Ratatotok sediment was 187.15 ± 194.46 ppb, but 137.91 ± 75.01 ppb at Buyat sediment.

Table 4. Mercury content (Hg)(ppb) in waters of Ratatotok and Buyat Bay

Sample	Ratatotok	Buyat
Marine Sediment	187.15 ± 194.46 (n = 20)	137.91 ± 75.01 (n = 9)
River Sediment	960.56 ± 229.85 (n = 4)	315.29 ± 139.08 (n = 3)
Gold Mining Illegal Sediment	266.67	-
Bottom Marine water	3.13 ± 3.26	1.28 ± 2.82 (n = 9)
Surface Marine Water	-	0.80 ± 1.52 (n = 9)
River Water	Ttd	Ttd

Source : BRKP DKP RI (2004)

Table 5. Mercury content (Hg) (ppb) in fishes caught from Ratatotok Bay and Buyat bay

Sample	Ratatotok	Buyat
Fishes	75.62 ± 60.20 (n = 32)	342.24 ± 277.88 (n = 26)
- Pelagic	72.84 ± 31.30 (n = 12)	335.55 ± 292.33 (n = 17)
- Demersal	77.28 ± 73.06 (n = 20)	469.74 ± 238.91 (n = 9)
Molusca		
- Squid	3.51	-
- Giant clam	-	19 851.49
- Sea cucumber	12.47	-

Source : BRKP DKP RI (2004)

Clark (1996) showed that generally pollutants in the form of chemical agents which can entering into aquatic ecosystem and quickly be accumulated within sediment at the bottom of

marine waters, which can be absorbed by plants and animals in that habitat. In general, mercury contamination in human occurred through consuming fishes and mussels. The bigger fish can be assumed to have the higher mercury content.

Mercury content in fish is being to be one of best indicator to know mercury pollution level in aquatic environment. Mercury content in fishes caught in Ratatotok Bay and Buyat Bay were shown on Table 6. Pelagic fishes (tuna, giant threadfish, spanish mackerel) contained mercury as about 72.84 ± 31.30 ppb at waters Ratatotok Bay and 335.55 ± 292.330 ppb at waters Buyat Bay. For demersal fishes (hairtail, bearded-croaker, grouper, long-jawed mackerel, big eye, yellow tail, goat fish) contained mercury approximately 77.28 ± 73.06 ppb in Ratatotok Bay and 354.90 ± 264.80 ppb Buyat Bay. Compared to *Maximum Permitted Concentration (MPC)* at level 0.5 ppm or 500 ppb, therefore the average content of mercury in fishmeat caught in Ratatotok Bay and Buyat Bay were still under diminishing level which can be permitted. Results gained by the joining between WHO Indonesia and Institute for Minamata Disease of Japan in the year of 2004 showed that the average content of mercury in fishes caught at Buyat Bay was 0.24 µ/g and 0.15 µ/g at Ratatotok Bay. At the time occurring Minamata disease in Japan, the average mercury content in fish was more than 10 µ/g.

III.C. Fish Cookies

Chemical aspects in fresh fishmeats can be shown at Table 6. As demersal fish, Long-jawed mackerel and Banded grunter have high level of proteins and low levels of fat.

Table 6. Nutritional aspects in Banded grunter (*Epinephelus heniochus*) and Long-jawed mackerel (*Nemipterus nematophorus*)

	Banded grunter Fish	**Long-jawed mackerel Fish**
Water (% bb)	79.04	76.94
Ash (% bb)	1.24	1.94
Fat (% bb)	1.99	1.92
Protein (% bb)	16.92	18.91
Carbohydrate (%bb)	0.81	0.29

Table 7 depicted the effect of soaking in 5% acetic acid on the mercury levels in fresh fish meat and fresh fish liver Followed to the safety standard announced by WHO as 0.5 ppm, therefore the amount of mercury levels in two kind demersal fishes used in this research were still under the safety standard of WHO.

Table 7. Effect of soaking in 5% acetic acid on mercury levels in fresh fishes caught in Buyat Bay (average from two analysis)

	Before Soaking in 5% Acetic Acid	After Soaking in 5% Acetic Acid	Reduction (%)
Dorsal meat of Banded grunter (Kerapu)(ppm)	**0.017**	**0.006**	**64.70**
pH Banded grunter's meat	6.75	3.64	
Dorsal meat of Long-jawed mackerel (Kurisi)(ppm)	**0.034**	**0.013**	**61.76**
pH Long-jawed	6.81	3.68	

mackerel's meat			
Liver of Banded grunter	**0.022**	**0.005**	**77.27**
Liver of Long-jawed mackerel	**0.062**	**0.007**	**88.71**

The meat and liver of Long-jawed mackerel fish contained mercury level higher than those of Banded grunter fish, as shown in Table 7.

After soaked in 5% acetic acid for 30 minutes towards on Long-jawed mackerel's and Banded grunter's meats and livers, it was shown that there was a reduction in mercury levels up to 64.70 and 88.71% (Table 7). This result showed that the use of 5% acetic acid could be effectively used to reduce mercury content in fishery products as human food. It presumably caused by the character of acid which could cut the unstable and complexity binding off between metal-protein, therefore metals would much higher dissolved during soaking process. Acetic acid is a solution which has been resulted from two kind fermentation processes, such as fermentation stage in a solution contained sugar to form ethanol followed by oxidation stage of ethanol to form acetic acid. Acetic acid is a weak acid and an organic acid, colorless, hard aroma, and dissolved in water/alcohol/glycerol. Even acetic acid is a weak acid, but presumably it can destroy complexity binding between metal and protein, and dissolves metal so that the amount of it is being reduced.

Bryan (1976) showed that generally mercury interacted and accumulated in protein. Interaction of metal ion with protein is in two forms, such as :

1. Metalloprotein, is the metal ion which strongly interact with protein, and that metal is being a part of protein, therefore the interaction formed is very stable and can only be cut through special treatments such as pH, temperature, chemical treatment, etc.
2. Metal-protein, in this system metal ion can be easily changed with other unstable proteins. The changing of this reaction is strongly affected by solution condition surrounding.

Mercury is also can effectively reacting with amino acids as sistein, lysine, histidine which each of them is being sulphur and nitrogen donor, and be able to form the stable reaction.

The accumulation of mercury in fish and other water animals are affected by kind of species, gender, and also physic-chemical characteristics of water (temperature, pollutants, organic materials in water). Further, contact duration time between organism and water can also affects accumulation ability of heavy metals on to fish and other water animals.

The accumulation of mercury in the body has a tendency to be concentrated in liver and kidney, since the attendance of protein in those organs which consists sistein amino acid (Fardiaz, 1992). In order to inhibit the occurrence of mercury poisoned therefore each country determines safety line against mercury in fishery product. Generally, countries in the world use the safety line announced by World Health Organization (WHO), as 0,5 ppm. Further, WHO and FAO also stated the amount of daily mercury intake as 30 µg total mercury per 70 kg body weight (Hutagalung, 1985).

Table 8. Proximate content of fish cookies

Description	Water (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Control	3.47	2.17	9.80	24.10	60.45
Cookies with 5% fish flesh flour	3.71	2.19	10.60	24.55	58.93

Cookies with 10% fish flesh flour	2.46	2.61	14.58	22.45	57.89
Cookies with 15% fish flesh flour	3.19	2.67	16.75	23.48	53.89

Table 9 . Effect of fish flesh flour addition on the protein digestibility of cookies

Description	Protein (% wb)	Undigested Protein (mg)	Protein Digestibility	Average Protein Digestibility
Control	10.25 9.36	34.49 33.33	82.75 83.18	82.96
Cookies with 5% fish flesh flour	10.78 10.42	40.14 42.62	79.93 78.72	79.32
Cookies with 10% fish flesh flour	14.99 14.16	36.06 34.24	81.76 82.99	82.37
Cookies with 15% fish flesh flour	16.77 16.74	39.81 38.38	80.11 80.84	80.47

Table 9 showed that the protein digestibility of cookies which have been supplemented by Banded grunter and Long-jawed mackerel fish flesh flours had high values and did not significantly different among them, as about 80%. However, it was shown that the amount of undigested protein in cookies was increased with the elevated percentage fish flesh flour added into the cookies formulation even the protein content was also increased. It is supposed that the increase of protein in fish flour will also increase the chemical (Maillard = non enzymic browning) reaction occurrence with carbohydrate which majority consisted in wheat flour used in cookies formulation, therefore this kind of reaction can decrease the availability of protein and also its digestibility, and objectively the result color of cookies product yielded can be shown at Table 10 below, which the darker brown color of cookies was achieved with the increase of fish flour added.

Table 10 . Physically characteristic of cookies added by banded grunter and long-jawed mackerel fish flesh flours

Description	pH	Aw	Hardness (gram force)	Whiteness
Control	6.07	0.39	1525.00	56.17
Cookies with 0.5% fish flesh flour	6.17	0.37	1508.34	52.73
Cookies with 1.0% fish flesh flour	6.26	0.35	1500	49.10
Cookies with 1.5% fish flesh flour	6.30	0.38	1508.34	40.07
Wheat flour				84.00
Flour of Banded grunter fish				42.33
Flour of Long-jawed mackerel				43.03

In this experiment was also done organoleptic test to know the cookies formulation which could be accepted by unskilled 30 consumers. The results of organoleptic test can be seen at Figure 1 up to 5 below. From those Figures, it can be seen that in all criterions (appearance, taste, aroma, color, texture), that the consumer preferences on fish cookies products were gradually decreased even not significantly different. However, all consumer preferences were all still above the neutral hedonic scale (4). The showing hedonic scales indicated that the higher scale tends to the more likely towards on the product given to the consumer.

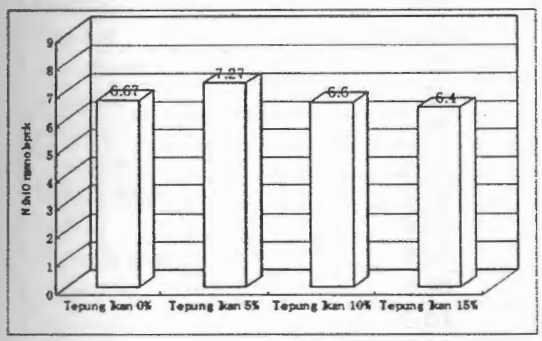

Figure 1. Hedonic test: Appearance

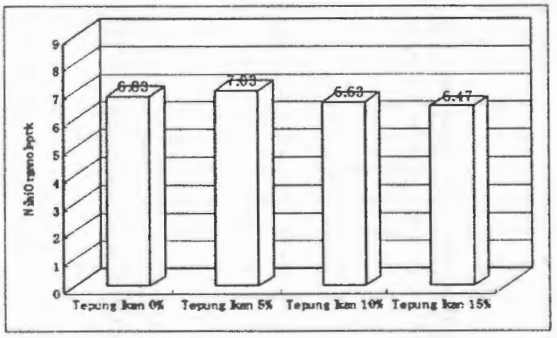

Figure 2. Hedonic test: Color

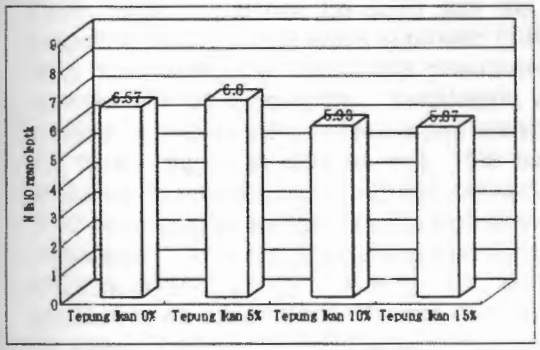

Figure 3. Hedonic test: Texture

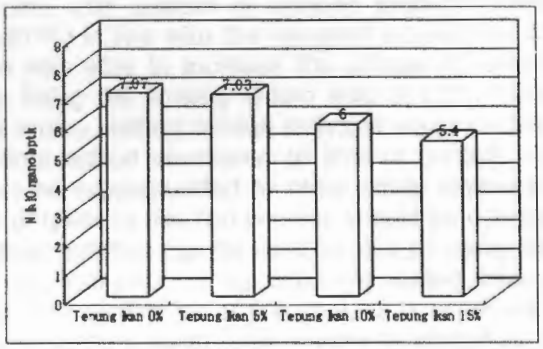

Figure 4. Hedonic test: Aroma

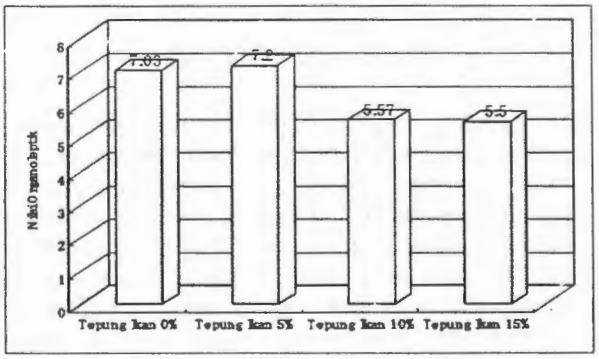

Figure 5. Hedonic taste: Taste

Table 11. Amino acid content in cookies

Amino acid	Cookies with 0% fish flesh flour (control)	Cookies with 5% fish flesh flour	Cookies with 15% fish flesh flour
Aspartic acid	0.46	0.73	1.28
Glutamic acid	2.64	2.78	3.47
Serine	0.40	0.43	0.61
Histidin	0.18	0.21	0.31
Glycine	0.31	0.39	0.58
Threonine	0.25	0.33	0.55
Arginine	0.35	0.49	0.78
Alanine	0.29	0.42	0.70
Tyrosine	0.22	0.26	0.40
Methionine	0.10	0.18	0.32
Valine	0.40	0.51	0.76
Phenilalanine	0.40	0.46	0.64
L-leusine	0.36	0.48	0.73
Leusine	0.61	0.78	1.15
Lysine	0.26	0.49	0.91

From Table 11, it can be seen that the amino acid content of cookies product (mainly essential amino acids) were improved (130-380 %) in line with the elevated increase of fish flesh flour added, in which this phenomenon was able to increase the protein content of cookies and its digestibility. Methionine was being the limiting amino acid in fish cookies product, however the most important essential amino acid for human as lysine was increased 4.5 times higher in cookies with 15% fish flour added compared to that of control. The limitation of methionine in this fish cookies can be supplemented by other richer methionine food component sources, but the high content of lysine in this fish cookies should be optimaly maintained. This result indicates that fish cookies product can be used as one of cheap and efficient protein source in human diet, which can also improve the economy added value of product when applicated in fishers community. The production of fish cookies is expected to be able to improve the fish consumption pattern in fishers community, mainly located at Buyat Bay area and be able to be wider accepted by people with all ages (children to old-aged) since cookies is being one of food product which easily to be consumed and be popular

IV. CONCLUSION

From this research, it was showed that the fresh flesh of Banded Grunter fish (*Ephinephelus* sp) and the flesh of Long-jawed mackerel fish (*Nemipterus* sp) caught from Buyat Bay on December 2004, naturally possessed lower mercury contents such as 0.017 ppm and 0.034 ppm than that of allowed by WHO as 0.5 ppm. Therefore, the mercury concentration in those two kind of demersal fishes used in this experiment were still below the standard and fishes are still safely used for human consumption, even without the soaking process in acid solution. However, soaking process of fish fleshes in 5% acetic acid for 30 minutes was successfully able to reduce the mercury content as 61.76-64.70%; further the soaking of fish livers in 5% acetic acid for 30 minutes was able to reduce the mercury content as 77.27-88.21%.

Fish cookies was made by the equal concentration of Banded Grunter and Long-jawed mackerel fleshes and added into the formulation of cookies with three level concentrations such as 5, 10, dan 15%. Thirty unskilled panelists could accept the cookies products containing all different concentrations without any significant differences, even the preference was gradually decreased with the increase concentration of fish flour added but still within the normal acceptance ranges. The chemical properties of cookies containing 15% fish fleshes

are followed : water 3.19%, ash 2.67%, crude protein 16.75%, crude fat 23.48%, and carbohydrate 53.89%; which is 80% higher than that of control cookies. The use of 15% fish in the formulation could increase the amount of essential amino acids as 130-380 %, mainly for lysine. Protein digestibility of cookies was about 79.32-82.96%, whereas the increase of fish concentration would also improve the protein digestibility of protein in cookies products.

Therefore the making of fish cookies is assumed being able to improve fish consumption pattern among community mainly in Buyat bay area, since the simplicity method used, well-known product, long storage time, improved economically added value, creating new income generating activity, and high protein quality.

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