Morphological Characterization of Various Nile Tilapias (Oreochromis Niloticus) in Lake Waters

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ABSTRACT

Nile Tilapia (Oreochromis niloticus) farming is common in Laguna Lake, Taal Lake and Sampaloc Lake. The main purpose of this study was to differentiate the morphology of Nile Tilapia in these lake, in terms of its external morphoanatomy including: size (length and width), weight, color of the skin, smell, and texture of the skin as well as its internal morphoanatomy which includes: color of the meat, color of the organs, and color of the gills and taste using hedonic scale for sensory analysis. Geographical differences and several environmental factors influence the morphoanatomy of nile tilapia living in the study sites. This was assessed through adapted dissection made by the researchers and boiling method for the sensory analysis. The characterization proved that there are external and internal morphological differences among the Nile tilapias. The results showed that Nile Tilapia, in Taal Lake had significantly pleasing external and internal morphological characteristics followed by the Sampaloc Lake, and lastly the most unpleasing and unpalatable of all is the Laguna Lake.

Keywords: *Nile tilapia, Oreochromis niloticus, dissection, external morphology, internal morphoanatomy, sensory analysis*

INTRODUCTION

Lakes are common in the Philippines. Due to this, the aquaculture and production of various aquatic resources are done in order to suffice human needs. Cage cultures and reservoirs are also done in order to provide sustainability in fish production. In relation to this, hearsays about the quality of taste of Nile Tilapia are rampant in public markets. In order to obtain a scientific proof, the researchers made the study in order to validate these hearsays. The species, Oreochromis niloticus or commonly known as the Tilapia, is the main focus of the study. This is because it is the most prominent commercially old fish in the area of research.

For the location of the study, the three well-known lakes, Laguna lake, Taal lake, and Sampaloc lake which are the limitations of the study. The three lakes are used as fish farming for Nile Tilapia (Oreochromis niloticus), thus showing that these three lakes have a common fish that dwell. Each lake offers different environment that can trigger the change in morphology of the fish. This study intends to provide current information about the Nile Tilapias which are common among these lakes. The study aims to provide a scientific assessment and validation of the external and internal morphology of Nile Tilapia.

Review of Literature

The Philippines became a pioneer of Nile tilapia (Oreochromis niloticus) cage culture in different lakes and reservoirs however prior to that, the profitable Nile tilapia farming in the Philippines began in the 1970's. It was introduced in pond and also in cage cultures. Nile tilapia farming is common in Taal Lake and Laguna Lake. (Romana-Eguia, Laron, & Catacutan, 2013). The fish species that is one of the most cultured in country is the Nile Tilapia (Oreochromis niloticus), which serves as the basis on what fish is farmed from the lakes. In addition, the second biggest contributor in producing Nile tilapia (Oreochromis niloticus) is the Taal Lake, intensive fish cage farming is happening in Taal Lake where people get their important source in economy which is used as the source of food and livelihood for the

residents which is living near the area. The aquatic system is continuing to worsen that directly affects to the quality of fish. (Oreochromis et al., 2016).

The location of harvest, the seven lakes which includes Sampaloc Lake has abundant Nile tilapia that compromises Nile tilapia (Oreochromis niloticus) and other species of freshwater fishes, however the most common fish species in the lakes is O. niloticus which is actually not a native fish. (Paller, Corpuz, & Bandal Jr, 2017). On the other hand, Nile tilapia (Oreochromis niloticus) can also be found in Sampaloc lake because it is the most important cultured aquatic species of the lakes which largely supports the people who makes fishery as their livelihood (Lakes, 2017). On the contrary, there is a different situation happening in Laguna lake, the problem in Laguna lake is that the lake is polluted which is mostly filled with domestic waste or heavy metals however the species underwater still survive in that area especially Nile tilapia (Oreochromis niloticus). It is actually one of the sources of livelihood of residents that live near the lake. (Wuyun, Ryo, & Ryohei, 2015).

Usually the Nile tilapia is sexually matured at age of 5-6 months wherein it is matured enough to be harvested. Raising Nile Tilapia is requiring short period of time which made easy for the farmers to produce sufficient supply. In result to this, the demand of Nile tilapia (Oreochromis niloticus) is increasing and so the farming method is improving. In effect the Nile tilapia is bred to supply the boosting demand of the fish to improve the quality that can result to morphological variation. This study shows that there are a bit morphological differences from several lake water systems in the area whereas the differences within the population indicate the genetic variation and/or such environmental factors that can affect. It is important to determine the morphological differences as fish such as Nile tilapia is grouped according to their morphological structure. (Mwanja et al., 2017). This study shows how invulnerable and adoptable Nile tilapia (Oreochromis niloticus) that even they roam in other lakes that is already contaminated or lakes that is not suitable to their whole system they can still make the place as their niche.

Objectives of the Study

Generally, the study aims to differentiate the morphology of Nile Tilapia (Oreochromis niloticus) in various lakes. Specifically, the study aims to identify the characteristics of Nile Tilapia in terms of external morphoanatomy includes size (length and width), weight, color of the skin, smell, texture of the skin and taste or sensory analysis and the internal morphoanatomy such as color of the meat, color of the organs, and color of the gills.

METHODOLOGY

The study is a descriptive type of research that was conducted in three selected lakes which are Laguna Lake, Sampaloc Lake and Taal Lake since these are the scope and limitation of their study. Moreover, the morphology of lake water Nile Tilapia was determined through obtaining 4 pieces/1 kilograms of fish samples from each lake then dissecting it. For the external morphoanatomy, the researchers measured the size which consists of the length the width, the weight in kilograms, the color, texture and odor of the skin through sensory evaluation was determined. For the internal morphoanatomy, the color of the meat, organs, and gills was observed. Furthermore, sensory analysis was done by traditional boiling method. The researchers boiled the Nile Tilapia for 30 minutes until it is disinfected, tender, and cooked. The sensory analysis is determined using the standardized Hedonic Scale. Lastly, the researchers also categorized the data that were gathered in order to provide information that are specified only to the three selected lakes.

RESULTS AND DISCUSSIONS

The sizes of the Nile Tilapia from the three lakes do not go far from each other. Although they have almost the same size, the Laguna Lake Tilapia was the smallest while the Taal Lake tilapia is the largest. In addition, the texture and smell is can be affected by various environmental factors in the lakes that they live in. For example, exposing the Nile Tilapia in heavy metals such as Cadmium (Cd), Lead (Pb), Mercury (Hg), Arsenic (As) and Chromium (Cr) that are present in its habitat can directly affect the taste, texture and color of the fishes in that area. The consumers, are directly affected as they consumed Tilapias that are exposed to such heavy metal increasing different health risks (Molina, Espaldon, Flavier, Pacardo, & Rebancos, 2011).

Table 1. External characteristics of Nile Tilapia

External Morphology	Habitat		
	Laguna Lake	Sampaloc lake	Taal Lake
Length	8.5 inches	9 inches	9.5 inches
Width	3 inches	3.5 inches	3.5 inches
Weight	250 grams	250 grams	250 grams
Skin Color	Pale	Bright	Dull
Skin Texture	Rough; slimy; muddy	Smooth; slimy	Smooth; waxy
Eyes	White iris; yellowish retina	White iris; orange retina	Blackish iris; blackish retina
Odor	Strong fishy smell	Moderate fishy smell	Mild fishy smell

Among the fish samples obtained by the researchers, the Nile Tilapia from the Taal Lake is the most notable for its external morphoanatomy which can indicate a good quality of habitat as compared to the other lakes. According to an article published by Asian Development Bank (2005), the Taal Lake is considered to be as the most suitable for marine wildlife to live in, thus making the external characteristics of Tilapia in this area to be remarkable.

Figure 1. External View of Nile Tilapia (*Oreochromis niloticus)*; From left, 1) Laguna Lake, 2) Sampaloc Lake, 3) Taal Lake

The figures exhibit the differences among the three tilapias especially in their colors of their external morphoanatomy. The Nile Tilapia in Taal Lake has the darkest color while the Nile Tilapia in the Sampaloc exhibited the palest color among the three Nile Tilapia Samples. On the other hand, the scale pattern of each Tilapia differs from each other as presented by the figures. The Nile Tilapia from Taal Lake shows white patches in its scales, while in Laguna Lake, Nile Tilapia shows a fine distribution of scale pattern and lastly, in Sampaloc Lake, its Nile Tilapia shows minimal white patches in its scale.

Different internal characteristics of Tilapias from various lakes can be observed having their own distinct features from one another. The overall color of the Nile Tilapia from the Laguna Lake is the most presentable among the tilapias obtained. There are environmental factors that can affect the color of the tilapia internally. Among the tilapias from three lakes Taal Lake is incomparable to its pleasant odor. The color and odor can be influenced by different factors which vary from each lake.

Table 2. Internal characteristics of Nile Tilapia

Internal Morphology	Habitat		
	Laguna Lake	Sampaloc lake	Taal Lake
Gills	Pale red; mucus translucent	Red; mucus translucent	Dark red or bright red; mucus translucent
Gills and internal odors	Strongly fishy smell; slightly sour	Moderate fishy smell; neutral odor	Mild fishy smell; fresh
Color of meat	Pinkish red	Pale white	Pale white
Color of organs	Reddish	Dull	Pale red

In the Sampaloc Lake, niche overlap is common especially to those non-native fishes present in the Lake. It affects the feeding diet of the tilapia to change influencing the color of the internal organ and also the meat. Aside from that, the present native submerged vegetation such as macrophytes indicates that the water quality is good providing the much diverse habitat that is functional for the organisms. (Briones, Papa, Cauyan, Mendoza, & Okuda, 2016). On the other hand, Laguna Lake is currently experiencing excessive pollution that directly affects the organisms such as Nile Tilapia that inhabits. The illegal reclamation, industrial waste, sedimentation and the untreated sewage and uncontrollable fishing are the main contributor of the pollution in Laguna Lake. The pollution does not just affect the organisms but also the water quality and the nutrients present in the lake. The presence of nitrogen and phosphorus results to the eutrophication affecting the plant growth which can lead to the oxygen deprivation in the lake. (Castro, 2017).

Moreover, the volcanic activities and other human influences are potential reasons for the mass mortalities and health risk of Tilapia in Taal Lake. (Asian Development Bank, 2005). On the contrary to its prominent impression, the Tilapia in Taal Lake is also experiencing different environmental factors which risk their living. This includes the potential Lake Waters pollutant caused by humans (Garcia, 2016).

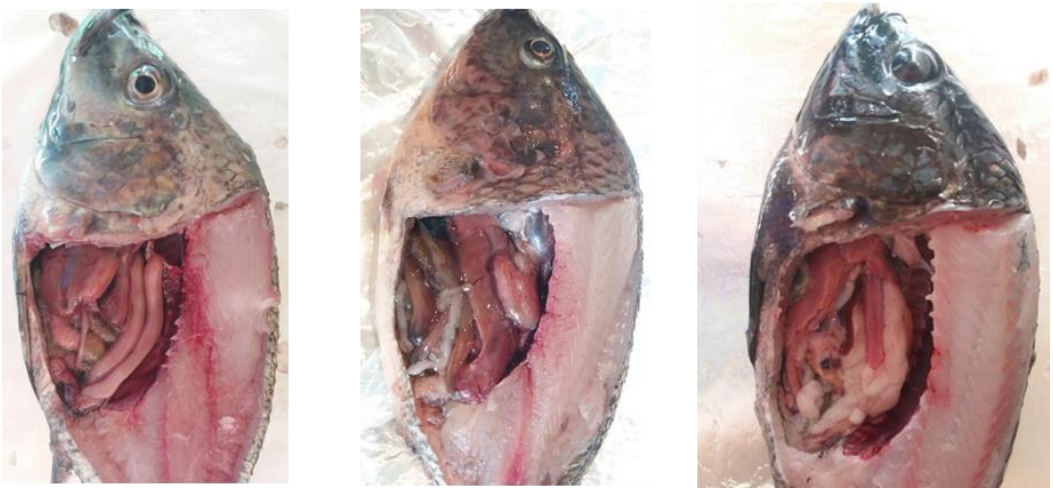

Figure 2. Meat and Organ View of Dissected Nile Tilapia (*Oreochromis niloticus*); From left 1) Laguna Lake, 2) Sampaloc Lake; 3) Taal Lake

The figure 4-6 shows the internal morphoanatomy of the Nile Tilapia which consists of the meat and the internal organs. It also indicated the color, odor and texture of the parts in the internal morphoanatomy. Each of the meat and organ view of dissected Nile tilapia shows different distinct features especially the looks of the meat, the Laguna lake shows a reddish pink color, Sampaloc and Taal lake with a pale white color.

Based from the results of taste testing, the Taal Lake fish was the most acceptable and pleasing taste. Next are the Sampaloc Lake which resembled a muddy taste in a mild way, and lastly the Laguna Lake which has a strong muddy taste. The boiled Tilapia is represented in Figure 7-9.

Table 3. Sensory Analysis

		Laguna Lake	Sampaloc Lake	Taal Lake
Color	Hedonic Scale Description	7 Like Very Much	7 Like Very Much	7 Like Very Much
Odor	Hedonic Scale Description	2 Dislike Very Much	6 Like Moderately	8 Like Extremely
Texture	Hedonic Scale Description	4 Dislike Slightly	6 Like Moderately	7 Like Very Much
Taste	Hedonic Scale Description	3 Dislike Moderately	6 Like Moderately	8 Like Extremely
General Acceptability	Hedonic Scale Description	5 Like Slightly	6 Like Moderately	7 Like Very Much

There are a lot of factors that can affect the flavor of the fish. The environment and season can contribute to this. The environmental factors not just compromised of temperature and water cycle but also the available food supply present in the area. The fatty acid that composes the muscle tissue of the fish can be influenced by the temperature that results to the alteration of the texture and the flavor. The environmental factors should be reduced in order to control not just the flavor but also the organoleptic characteristics of a fish through their diet. (Spinelli, 2013).

Figure 3. Boiled Nile Tilapia (*Oreochromic niloticus*); From left 1) Laguna Lake, 2) Sampaloc Lake, 3) Taal Lake

The cooking method can potentially affect the content of the fish samples. Moreover, the studies showed that the longer boiling time can contribute to the increase of some content of the product of the sample (Suryaningrum, 2013). Boiling method is just one the varieties of cooking method to come up with the taste test of fish samples. The researcher used the traditional boiling method of cooking in order to retain the content and the nutrients of the fish samples. The traditional boiling method is used in this study whereas the temperature is not determined, however the cooking time where standardized into 30 minutes in order to have coherent result. The samples were assured not be overcooked as this can affect to the taste and content of the Nile Tilapia.

CONCLUSIONS AND RECOMMENDATIONS

The morphology of Nile tilapia from various lakes shows significant distinction. Results shown that the differences are seen in both external morphoanatomy and internal morphoanatomy of the Nile tilapia from Laguna, Sampaloc, and Taal Lake. For the external morphoanatomy, the sizes of the Nile Tilapia do not vary from each other that much although they have different habitats. This also showed that Nile Tilapia in the Taal Lake was the smallest of the three. In addition, smell and texture which falls under the external morphoanatomy exhibited various odors that signify the environmental condition of the lake that they are in. Laguna Lake Nile Tilapia's taste, texture and color were affected due to the concentration of heavy metals in the lake namely: Cadmium, Lead, Mercury, Arsenic and Chromium. On the other hand, Nile Tilapia from Taal Lake exhibited a pleasing external morphoanatomy which shows a good quality of habitat that they live in.

As for the internal morphoanatomy, the Tilapias from the three Lakes are potentially influenced by the environmental factors that they experience in the habitat that they inhabit. In Sampaloc Lake, an occurrence of niche overlap affects the diet of the Tilapia which contributes to the change in internal morphoanatomy of the fish that compromises the color of its internal organ and meat. Moreover, Nile Tilapia in Laguna Lake showed a different color as compared to the other two fishes. This is potentially caused by the high level of pollution in the Laguna Lake itself. The Nile Tilapia is not just the only one affected by this pollution but also the nutrient content of the lake which can influence the diet of the fish. Lastly, the internal morphoanatomy of Nile Tilapia from Taal Lake showed a dull color of its meat and

internal organs. Environmental and human factors influences are few of the causes for the health risk of Tilapia in the Taal Lake.

Results also showed that the Sensory Analysis of Nile Tilapia from various lakes significantly differs. The Taal Lake's Nile Tilapia had the most acceptable and pleasing taste as based on the Hedonic Scale Scoring Scale. Next to this evaluation is the Nile Tilapia from Sampaloc Lake which was moderately liked by the respondents. Lastly, the Nile Tilapia in Laguna Lake was evaluated as to be unpleasing since it was disliked moderately. The flavor of the fishes is influenced by a lot of factors including the environment and the season that is currently taking in place. Alterations of the texture and flavor are one of the results from these factors affecting the Nile Tilapia.

For future researchers, they could extend the research by correlating the external morphoanatomy and internal morphoanatomy of Nile Tilapia as an indicator for quality of lake waters. In addition, the effects of various species in the environmental condition should be taken into consideration for its relevance to the morphoanatomy of Nile Tilapia. Nutritional quality of Nile tilapia from these lakes can be assessed as well.

REFERENCES

Asian Development Bank. (2005). CASE STUDY 6 : TILAPIA CAGE FARMING IN LAKE TAAL , BATANGAS , PHILIPPINES Scope and Purpose This case study was undertaken as part of an Asian Development Bank (ADB) special evaluation study on small-scale , freshwater , rural aquaculture development . Governance An International Journal Of Policy And Administration, 95–119. Retrieved from http://www.adb.org/Documents/Evaluation/Case-Studies/SmallScale-Freshwater-RuralAquaculture-Devt/phi-case6.pdf

Briones, J. C. A., Papa, R. D. S., Cauyan, G. A., Mendoza, N., & Okuda, N. (2016). Fish diversity and trophic interactions in LAKE SAmpaloc (Luzon Is., Philippines). Tropical Ecology, 57(3), 567–581. Retrieved from https://www.researchgate.net/publication/295507790_Fish_diversity_and_trophic_interactions_in_LAKE_SAmpaloc_Luzon_Is_Philippines

Castro, R. (2017). Battling pollution in the Philippines' largest lake. Ekp, 13(3), 1576–1580. Retrieved from https://www.thegef.org/news/battling-pollution-philippines'-largest-lake

Garcia, E. C. (2016). Beach Resorts Operation as Potential Lake Water Pollutants: Sketches on Synergy among Stakeholders. LPU-Laguna Journal of Multidisciplinary Research, 5(1), 85–99. https://doi.org/10.15242/ijacebs.h0617210

Molina, V. B., Espaldon, M. V. O., Flavier, M. E., Pacardo, E. P., & Rebancos, C. M. (2011). Bioaccumulation in Nile tilapia (oreochromis niloticus) from Laguna de bay, Philippines. Journal of Environmental Science and Management, 14(2), 28–35.

Mwanja, M., Ondhoro, C., Sserwada, M., Achieng, P., Ddungu, R., & Mwanja, W. (2017). Morphological variation of Nile tilapia populations from major water bodies of Uganda. Uganda Journal of Agricultural Sciences, 17(1), 21. https://doi.org/10.4314/ujas.v17i1.3

Oreochromis, T., Lake, T., Bang-asan, M. R., Mitsuhashi, M. V, Balolong, M. P., & Hallare, A. V. (2016). Histopathological Effects of Aquafarming on the Liver and Testes of Nile Histopathological Effects of Aquafarming on the Liver and Testes of Nile Tilapia (Oreochromis niloticus L .) from Taal Lake , Philippines. (June).

Paller, V. G., Corpuz, M. N., & Bandal Jr, M. (2017). Freshwater Fish Assemblages and Water Quality Parameters in Seven Lakes of San Pablo, Laguna, Philippines. 8(January), 1–22. https://doi.org/10.7828/ajob.v8i1.995

Romana-Eguia, M., Laron, M., & Catacutan, M. (2013). On-farm feed management practices for Nile tilapia (Oreochromis niloticus) in the Philippines. 131–158. Retrieved from http://www.fao.org/tempref/FI/CDrom/T583/root/03.pdf

Spinelli, J. (2013). Chapter 12 . Unconventional Feed Ingredients for Fish Feed. FAO Fisheries and Aquaculture Technical Paper, 1–20. Retrieved from http://www.fao.org/3/x5738e/x5738e0d.htm

Suryaningrum, T. D. (2013). Quality Changes of Boiled Salted Carp Fish (Cyprinus carpio) Using Steaming and Boiling Methods , During Chilling Storage Perubahan Mutu Pindang Ikan Mas (Cyprinus carpio), yang Diolah dengan Teknik Pemanasan Berbeda Selama Penyimpanan pada Suhu Dingi. 8(2), 77–86. https://doi.org/10.15578/squalen.v8i2.89

Wuyun, G., Ryo, S., & Ryohei, K. (2015). Understanding local fish consumption behavior in Laguna Lake watershed area, Philippines. African Journal of Food Science, 9(4), 176–181. https://doi.org/10.5897/ajfs2014.1246