IMPACT OF DETERGENT WASTE ON SURVIVAL, GROWTH, AND HISTIPHATOLOGY ON NILE TILAPIA (*Oreochromis niloticus*) CULTURE

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Abstract

Surfactant is active agent in detergent may affect pollution in the water. The purpose of this experiment is to examine the effect of surfactant on growth, survival, and histopathology of gill, kidney, and liver tissues on Nile tilapia (*Oreochromis niloticus*) culture. The aquarium with 70 x 40 x 45 cm was used. Fish with 8,46 ± 0,1 cm in total length was used. Stock density was 40 fishes per aquarium. The different of surfactant concentration used in this experiment were as follow: A) 1,5 mg/L; B) 3,0 mg/L; C) 4,5 mg/L; and D) 6,0 mg/L. Each treatment consisted of tree replicates. The experiment was conducted for 2 months. The result showed that The highest of survival (98.33 ± 2.89 %) at B treatment was found, and then followed by C, A and D treatments were 90.00 ± 6.61%, 89.17 ± 9.46%, and 89.17 ± 6.29 % (P>0,05), respectively. The body weight (6.5 ± 0.7 g) was the highest at D treatment then followed by B, and C were 5.72 ± 1.54 g, 6.5 ± 1.39 g and 5.06 ± 0.83 g (P>0.05), respectively. The kinds of damaged of gill, kidney, and liver tissue found such as lesion, swelling, vacuolation, blood, and necrosis were observed

Key word: Detergent, survival, growth, histopathology, Nile tilapia

1. INTRODUCTION

Water pollution is serious problem affect negative effect on aquatic life. Water pollution is caused by anthropogenic activities. Detergent is one source that influence aquatic environment. Detergents are widely used in both industrial and domestic premises to wash equipment, installations, heavy duty machines, vehicles and oil soiled materials. Detergents are cleaning products derived from synthetic organic chemicals. Detergent production from petrochemical sources with its ability to foam when used in acid or hard water gives it an advantage over soaps (Okpokwasili and Nwabuzor, 1988). Surfactants are the components mainly responsible for the cleaning action of detergents. In commercial detergents, the surfactant component is between 10 and 20%. The other components include bleach, filler, foam stabilizer, builders, perfume, soil-suspending agents, enzymes, dyes, optical brighteners and other materials designed to enhance the cleaning action of the surfactant (Okpokwasili and Nwabuzor, 1988). Detergent surfactants are complex organic chemicals where hydrophilic and hydrophobic groups are joined together in the same molecules (Huang *et al.*, 2000). There are various types of surfactants used in detergents formulations; the linear alkylbenzene sulfonate (LAS)-ionic surfactants is the most widely used (McAvoy *et al.*, 1997). It has been reported that LAS is easier to degradable compare to ABS (Gledhill, 1974). However, LAS is still hard to degrade in the water. Thus, surfactant type of LAS is needed to be evaluated.

McAvoy *et al.*, (1997) reported that to poorly degrade in rivers, lakes and ponds this may be toxic to aquatic organism and can also induce severe damage to vital organs and

even haematological, hormonal and enzyme disturbances (Ogundiran *et al*., 2009). Toxic chemicals cause tissues damage and histophatological degradations as the fish show haematological responses to toxicants; and generally, such degradation of histological origin occurs in the gills, livers, heart, kidney and epidermis of animals (Ogundiran *et al.*, 2007; Ogundiran *et al*., 2009; Ogundiran *et al.*, 2010). Therefore, effect of surfactant on Nile tilapia (*Oreochromis niloticus*) should be investigated.

The objectives of this experiment are to examine of surfactant on survival, growth, and histopatological such as gill, liver, and kidney of Nile tilapia under culture condition.

2. MATERIALS AND METHODS

The experiment was conducted from September to October 2011 at Research Installation for Freshwater Aquaculture Environment and Toxicology, Cibalagung, Bogor. The experiment was conducted in the laboratory. 12 of aquarium with volume of 70 cm long x 40 cm wide x 45 cm high were used. .Nile tilapia with 8.46 ± 0.1 cm in total length was used as a fish test. Stock density was 40 individuals per aquarium. Artificial diet was fed 3% per biomass per day. Active agent used surfactant as a treatment with consisted of three replicates. The difference concentrations of surfactant as a treatments were as followed: A) 1.5 mg/L; B) 3.0 mg/L; C) 4.5 mg/L and D) 6.0 mg/L

Parameters observed involving absolute growth, survival, and histophatology of gill, liver, and kidney. Statistical analysis using Complete Randomize Design with pos hoc multiple comparisons of Tukey's test were performed in order to determine the differences among the treatments.

3. RESULTS AND DISCUSSION

Fish survival and absolute weight growth of Nile tilapia (*Oreochromis niloticus*)

Survival rate and absolute weight growth of Nile tilapia (*Oreochromis niloticus*) were shown at Figure 1 & 2.

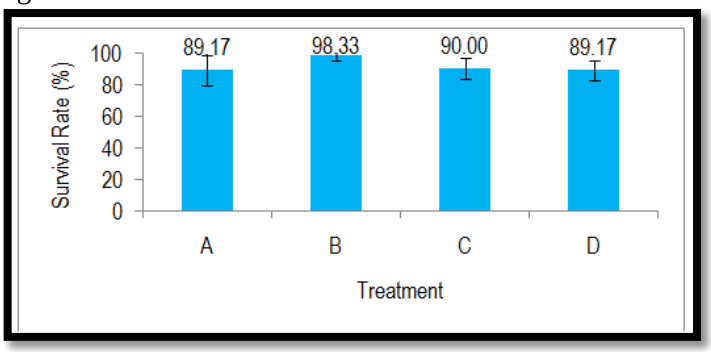

Figure 1 Survival rate of Nile tilapia (*Oreochromis niloticus*) culture at different from surfactant concentrations. A) 1.5 mg/L; B) 3.0 mg/L; C) 4.5 mg/L; and D) 6.0 mg/L

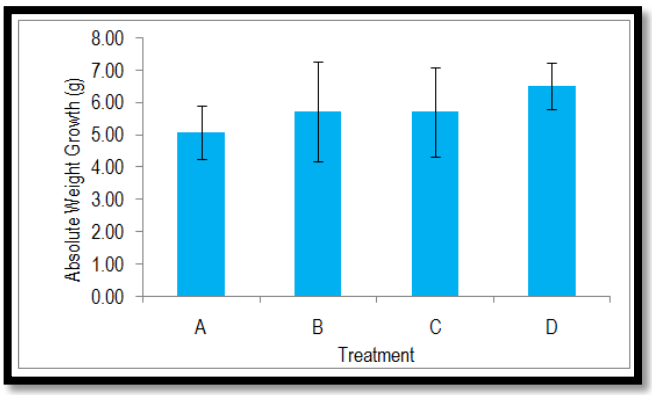

Figure 2 Absolute weight growth of Nile Tilapia (*Oreochromis niloticus*) culture at different from surfactant concentration. A) 1.5 mg/L; B) 3.0 mg/L; C) 4.5 mg/L; and D) 6.0 mg/L

The highest of survival rate of Nile tilapia culture at different surfactant concentration found at B treatment (98.33 ± 2.89%) followed by C (90.00 ± 6.615%), A (89.17 ± 9.46%), and D (89.17 ± 6.29%). Statistical analyzed revealed that no significantly different among the treatments (P>0.05). Absolute weight growth at D treatment (6.5 ± 0.72 g) was the highest compared to B (5.72 ± 1.54 g), C (5.70 ± 1.39 g), and A (5.06 ± 0.83 g). Statistical analyzed revealed that no significantly different among the treatments (P>0.05). Thus, it can be explained that surfactant did not effect on survival and growth of Nile tilapia. We suspected that the surfactant concentration used in this experiment might be chronic effect, therefore, it did not influence on survival and growth. The same result had also been reported that no negative effect of surfactant on survival and growth (Rejeki *et al*., 2006).

Histological of gill, liver, and kidney

Histopathological of gill, liver and kidney tissues of Nile tilapia culture at different surfactant concentration were shown in Figure 3 - 5

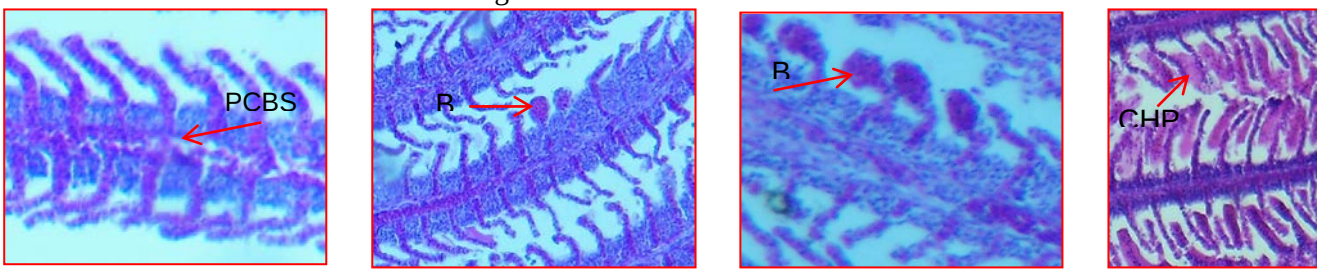

Figure 3 (A, B, C, D) Light micrographs of a transverse section of Nile tilapia gill tissues at different from surfactant concentration. (A) Surfactant concentration of 1.5 mg/L. Gill tissue showed partial congestion of the blood space (PCBS). (B) Surfactant concentration of 3.0 mg/L. The Lamella of gill was ballooning dilatation (BD). (C) Surfactant concentration of 4.5 mg/L. The lamellae of gill were ballooning dilatation (BD). (D) Surfactant concentration of 6.0 mg/L. The lamellae of gill were cellular hyperplasia (CHP).

Histological of gill at different concentrations of surfactant (Fig.3 A-D) showed the gill damage was increase with increasing surfactant concentration. We suggested that surfactant was surely affected the gill organ cells degeneration. Based on histological observed, ballooning dilatation of gill lamellae were more common with increased in surfactant concentration where hyperplasia at the lamellae, blood vessel, necrosis, and ephitelial thickening of lamellae found at the highest exposed to surfactant concentration was observed. The ballooning dilatation might be indicator feature of the gill damaged due to surfactant. This condition can be explained that the gills are the first target organ of several pollutants because of their very large interface area between external and internal fish environment, performing vital functions such as gas exchange and ion osmoregulation. Moreover, gills are also partially sensitive to adverse environmental conditions. Gomes *et al.* (2011) reported that most of the gills injuries are caused by expose to pollutant affect the lamellar epithelium. Ours result agreed with the features of the gill expose to surfactant had also been investigated by Ogundiran *et al*. (2009). The cellular hypertrophic condition observed, led to a decrease in the respiratory capacity between the lamellae, impairs the diffusion of oxygen across the gills due to the swollen condition of the epithelium and decrease in free gas exchange which in turn limits the compensatory changes that makes organism in question to become unadaptive when the duration of exposure and the concentrations of the effluents exceeds biological tolerance limits (Gomes *et al.*, 2011). Although the gills injuries occurred due to surfactant, however, it did not effect on fish growth and survival (Figure 1 & 2). This might be the surfactant concentration used in this experiment was within in the sub lethal concentration or chronic effect, thus, even if the gills had damaged but the fish were still able to tolerate such condition.

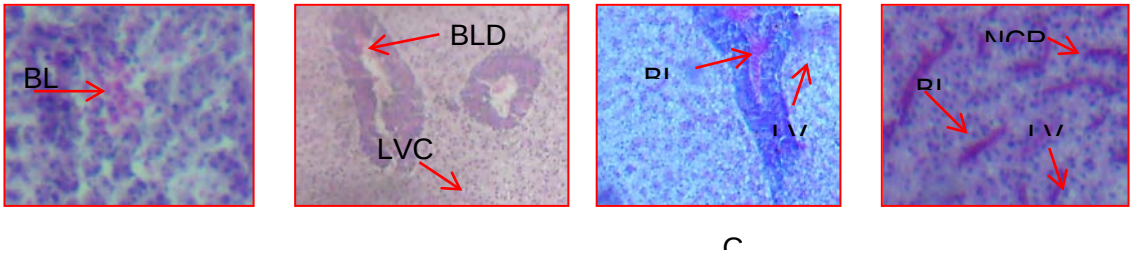

Figure 4 (A, B, C, D) Light micrographs of a transverse section of Nile tilapia liver tissues at different from surfactant concentration. (A) Surfactant concentration of 1.5 mg/L. There was blood (BLD) on the liver tissue. (B) Surfactant concentration of 3.0 mg/L. There were blood (BLD) and lipid vacuoles (LVC). (C) Surfactant concentration of 4.5 mg/L. There were blood (BLD) and lipid vacuoles (D) Surfactant concentration of 6.0 mg/L. There were Blood (BLD), lipid vacuoles (LVC), and necrosis (NRC).

Liver histological (Fig. 4 A-D) at different surfactant concentrations showed blood, lipid vacuole, and necrosis were observed. The damaged such those features were frequently occurred that led to increasing in surfactant concentration where the most of liver tissue had been degeneration. Thus, surfactant has been able to affect liver tissue distortion. Liver has function as a filter or detoxification of any toxicants that enter in the body. The ability of the liver to detoxification of toxicants is limited and depended on fish species. Thus, accumulation of the pollutant in the liver would result in liver damage. Similar result had been reported that detergent is generally related to important hepatic lesions such as degenerative and necrotic processes (Chang *et al*., 1998; Pacheco and Santos, 2002). Anomalies such as irregular shaped central vein, cellular vacuolation and infiltration may be attributed to the accumulation of lipids and glycogen due to liver dysfunction as a results of exposure to surfactant had been reported (Ogundiran *et al*., 2010). Even if most of the liver tissues showed degeneration but it did not affected in term of fish growth and survival. We suggested that the surfactant concentration might be in the sub lethal condition.

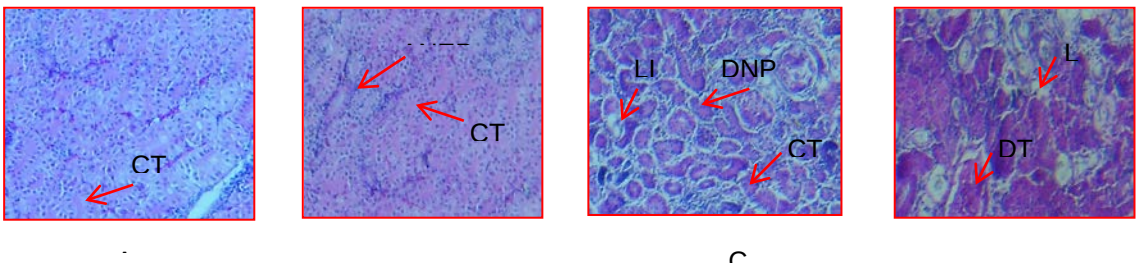

Figure 5 (A, B, C, D) Light micrographs of a transverse section of Nile tilapia kidney tissues at different from surfactant concentration. (A) Surfactant concentration of 1.5 mg/L. There was congestion of tubular. (B) Surfactant concentration of 3.0 mg/L. There were congestion of tubules (CT) and atrophy nefrocytes epithelium processes (ANEP). (C) Surfactant concentration of 4.5 mg/L. There were congestion of tubules (CT), disruption of nefrocytes epithelium processes (DNEP), and leucocitary infiltrates (LI). (D) Surfactant concentration of 6.0 mg/L. There were leucocitary infiltrates (LI) and disruption of tubules (DT).

Feature of kidney histological of Nile tilapia cultured at different surfactant concentration showed that the kidney histopathological damage was increased in increasing surfactant concentration. At low surfactant concentration (Fig. 5A) the kidney histological damaged found only congestion tubule was observed, but following the highest concentration was found leucocitary infiltrate and disruption of tubules (Fig. 5D). This fact that, surfactant can be influenced kidney tissue. Even low concentrations of detergent effluent can induce various toxicological effects and histological degradation, which dependent on the period of exposure and concentration of toxicant (Ogundari *et al*., 2010).

4. CONCLUSION

Based on the result of this experiment can be concluded that surfactant did not significantly affect fish grow and survival. Surfactant has been able to influence of histological of gill, liver, and kidney where the damage becomes increase with increasing concentration.

REFFERENCES

Chang, S.V. Zdanowicz and R.A. Murchelano. 1998. Associations between liver lesions in winter flonder (*Pleuronecte Americans*) and sediment chemical contaminants from north-east United States estuaries. J Marine Sci. 55:954-969.

Gledhill, W. E. 1974. Linear Alkybenzene Sulfonates: Biodegrdation and Aquatic interactions Adv. Appl. Microbiol. 17:265-293.

Gomes I. D., Nascimento A. A., Sales A., Araújo F. G. 2011. Can fish gill anomalies be used to assess water quality in freshwater Neotropical systems? Environment Monitoring Assessment.

Huang, X., Ellis, T. G. and Kaiser, S. K. 2000. Extant Biodegradation Testing with Linear Alkbenzene Sulfonate in Laboratory and Field activated sludge Systems. *WEFTEC* 2000. *Water Environment Federation.*

Mcavoy, D. C., Eckhoff, W. S. and Rapaport, R. A. 1997. The fate of Lineart alkylbenzene sulfonates in the environment. The Clear Review 3(1):4-7.

Ogundiran M. A., Fawle O. O., Adewoyw S. O., and Ayandiran T. A. 2010. Toxicological impact of detergent effluent on juvenile of African Catfish *(Clarias gariepinus)* (Buchell 1822). Adriculture and Biology Journal of North America, 1 (3): 330-340

Ogundiran M. A., Fawole O. O., Adewoye S. O., and Ayandiran T. A. 2009. Pathologic lesions in the gills of *Clarias gariepinus* exposed to sublethal concentrations of soap and detergent effluents. Journal of Cell and Animal Biology 3 (5): 078-082

Ogundiran, M. A.,Fawole, O. O., and Adewoye, S. O. 2007. Effects of Soap and Detergent Effluents on the Haematological Profiles of *Clarias gariepinus*. Science focus 12(1) 84-88.

Okpokwasili GO and Nwabuzor CN. 1988. Primary biodegradation of anionic surfactants in laundry detergents. Chemosphere 17: 2175-2182.

Pacheco, M. and Santos, M.A. 2002. Biotransformation, genotoxic and histopathological effect of environmental contaminants in European eel (*Anguilla anguilla*).*Ecotoxicological and Environmental Safety*, 53: 331-347.

Rejeki S., Desrina, and Mulyana A. R. 2006. Chronic affects of detergent surfactant (Linear Alkylbenzene Sulfonate/LAS) on the growth and survival rate of Sea Bass (*Lates calcalifer* Bloch) larvae. Thesis, UNDIP, Indonesia.

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