REVISTA DE AGROECOLOGIA NO SEMIÁRIDO
ISSN: 2595-0045
IFPB | Campus Sousa

NOTA TÉCNICA

POWER FAILURE IN THE BIOFLOC CAUSED FISH MORTALITY BY AMMONIA – CASE REPORT

Adolfo Jatobá[1] & Maurício Lehmann[2]

Abstract: The goal of this work was to explain the mortality of Nile tilapia (*Oreochromis niloticus*) reared in Bio-floc Technology (BFT), after a power failure. Six hundred Nile tilapia juveniles were being reared into three polyethylene tanks with BFT. In March 2018, a power failure occurred for about 12 minutes. Dissolved oxygen and temperature were constantly measured after reconnecting the power, while total ammonia nitrogen (TAN) was measured 5 minutes after reconnecting the system power and 12 hours late. Fish mortality was quantified 1, 2, 6 and 12 hours after reconnecting the system power. The water temperature did not alter during the power failure and dissolved oxygen was below 1.0 mg.L^{-1}, however, five minutes after reconnecting the system power, dissolved oxygen were restored above 4.9 mg.L^{-1}. Six hours after reconnecting the system power the mortality were 8.11% of the population and 100.0% after 12 hours. After 5 min TAN was 11.28 mg.L^{-1} and 12 hours later the concentration was above 125.00 mg.L^{-1}. The cause of fish mortality was the increase in the TAN concentration, due to the lack of oxygen during the power failure.

Palavras- chave: *Oreochromis niloticus*; aquaculture, nitrogen compounds; nitrification

FALHA ELÉTRICA EM BIOFLOCOS CAUSA MORTALIDADE POR AMÔNIA EM PEIXES – RELATO DE CASO

Resumo: O objetivo deste trabalho foi explicar a mortalidade da tilápia do Nilo (*Oreochromis niloticus*) criada em sistema de biofloco (SB), após uma falha elétrica. Seiscentos juvenis de tilápia-do-nilo estavam sendo criados em três tanques de polietileno com SB. Em março de 2018, ocorreu uma falha elétrica por cerca de 12 minutos. Oxigênio dissolvido e temperatura foram medidos constantemente após reconectar a energia, enquanto o nitrogênio amoniacal total (NAT) foi medido 5 minutos após reconectar a energia do sistema e 12 horas depois. A mortalidade foi quantificada 1, 2, 6 e 12 horas após a reconexão da energia do sistema. A temperatura da água não se alterou durante a falha elétrica, o oxigênio dissolvido ficou abaixo de 1,0 mg.L^{-1}, porém cinco minutos após a reconectar o sistema elétrico, o oxigênio dissolvido foi restaurado acima de 4,9 mg.L^{-1}. Seis horas após reconectar a alimentação do sistema, a mortalidade foi de 8,11% da população e 100,0% após 12 horas. Após 5 min o NAT era de 11,28 mg.L^{-1} e 12 horas depois a concentração estava acima de 125,00 mg.L^{-1}. A causa da mortalidade dos peixes foi o aumento da concentração de NAT, devido à falta de oxigênio durante o apagão.

Palavras - chave: *Oreochromis niloticus*, aquicultura, compostos nitrogenados, nitrificação

*Autor para correspondência
Recebido para publicação em 16/06/2021; aprovado em 23/12/2021
[1]Doutor em Aquicultura, Laboratório de Aquicultura, Instituto Federal Catarinense, *Campus* Araquari, jatobaadolfo@gmail.com
[2]Doutor em Aquicultura, Laboratório de Aquicultura, Instituto Federal Catarinense, *Campus* Araquari, mauricio.lehmann@ifc.edu.br
DOI: http://dx.doi.org/10.35512/ras.v5i4.6063

INTRODUCTION

The Bio-floc Technology (BFT) can expand the aquaculture production without increasing the use of the basic natural resources (water and land). This technology has become a promising alternative to promote the sustainability and biosecurity of aquatic animals by the utilization of smaller volumes of water, causing less damage to the environment (Avnimelech, 1999; Naylor *et al*., 2000). And fish reared in BFT grants equal and/or better growth performance than in conventional systems, making fish farming more sustainable (Jatobá et al., 2019).

However, this system requires the excessive use of energy for continuously high aeration and water mixing, as well as alarms and emergency power supply. This means that BFT can increase operating cost due the excessive use of energy (El-Sayed, 2021).

Thus, the goal of this work was to explain the mortality of Nile tilapia (*Oreochromis niloticus*) reared in BFT, after a power failure.

METHODOLOGY

This case occurred at Laboratório de Aquicultura (LAq), of Instituto Federal Catarinense (IFC), campus Araquari, (Protocol number 0190/2017 approved by animal ethics committee).

Six hundred Nile tilapia juveniles (*Oreochromis niloticus*), with an average weight of 5.32 ± 0.45 g were divided into three polyethylene tanks. Three days before the stocking with fish in rectangular tanks (250 L) the water fertilization was carried out with a carbon source (sugar) and powdered diet to keep the carbon:nitrogen (C:N) ratio 10:1, (Avnimelech, 1999; Ebeling *et al*., 2006) resulting in an initial solids concentration of 200.0 mg l^{-1}. Seven days after fish stocking fertilization was maintained at 10:1 (C:N) to neutralize 40% of the feed nitrogen and to keep the ammonia below 1.0 mg L^{-1}. Calcium carbonate was added when alkalinity fell below 30 mg.L^{-1} $CaCO_3$, and when necessary, the dose was 10% of the daily ration. Aeration system was provided with a 1/6 horsepower air blower and temperature (28 – 30°C) was kept with thermostat (Eheim, 250 Watts).

The initial stocking density was 800.0 fish per m³. Fish were fed three times per day (8:00, 11:00 and 16:00 hours), with commercial diet (GuabiTech QS, 1.0%, 45% crude protein, 8% ethereal extract, 3.0% crude fiber, 1.6% ash, 3.0% calcium, 1.4% phosphorus, manufacturer guarantee levels), on 5% of the fish biomass.

Dissolved oxygen and temperature (YSI55; YSI Incorporated, Yellow Springs, OH, USA) were verified twice a day (09:00 and 15:00 hours). Total suspended solids (TSS) (APHA, 2005 − 2540 D), pH and alkalinity (APHA, 2005 − 2320 B) were monitored twice a week. Fiberglass microfilters (0.6-m, GF-6 Macherey-Nagel, Düren, Germany) were used for TSS analysis.

Ammonia (total ammonia nitrogen − TAN), nitrite-N and nitrate-N were also monitored twice a week according to APHA (2005).

In March 2018, after four weeks, a power failure occurred for approximately 12 minutes. During the blackout, three air pumps (Boyu D-200 battery) were inserted in the tanks. Dissolved oxygen and temperature were constantly measured after reconnecting the power, but TAN was measured 5 minutes after reconnecting the system power and 12 hours later. Mortality (%) was quantified 1, 2, 6 and 12 hours after reconnecting the system power.

RESULTS AND DISCUSSION

Dissolved oxygen above 5.5 mg.L^{-1}, temperature (28.4 – 29.5 °C), TSS (max - min. 200.0 - 356.7 mg.L^{-1}), pH (6.87 – 7.18) ,alkalinity (max - min. 35.6 – 86.1 g $CaCO_3$ L^{-1}), TAN (max - min. 0.00 – 6.06 mg L^{-1}) nitrite-N (max - min. 0.00 – 7.39 mg L^{-1}) and nitrate-N (max - min. 0.00 – 10.3 g L^{-1}) were adequate to reared Nile tilapia in BFT before the power failure. And no mortality was observed in the four weeks leading up to the power failure.

The water temperature did not alter during the blackout, as the period without power was short, and probably the heaters did not lose temperature. But dissolved oxygen was below 1.0 mg.L^{-1}, which is below the recommended for Nile tilapia. However, five minutes after reconnecting the system power, dissolved oxygen were restored above 4.9 mg.L^{-1} (Figure 1) and no mortality has been recorded, only the presence of fish swimming on the tank surface has been noticed. The first dead fish were collected one hour after reconnecting the system power, 4.50% of population, this number increased to 8.11% six hours after reconnecting power system. However, overnight all fish died (Figure 2) without visible clinical signs of disease.

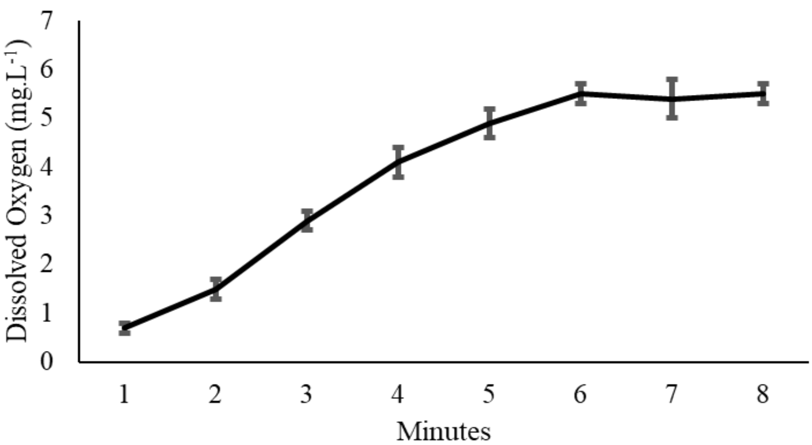

Figure 1- Dissolved oxygen after reconnecting the system power on biofloc water.

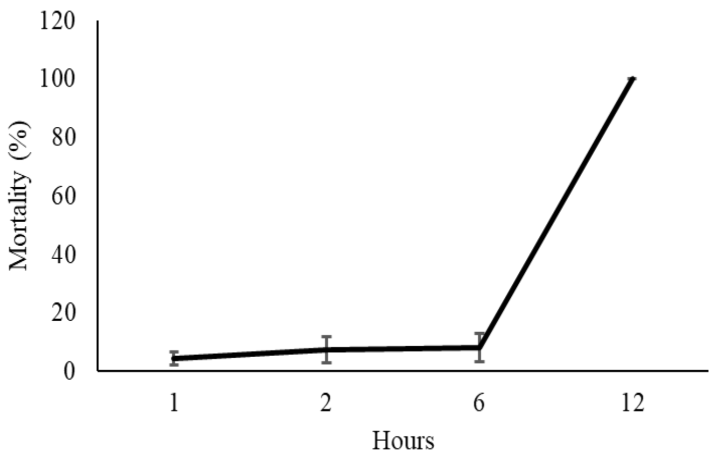

Figure 2 - Nile tilapia mortality in biofloc, after reconnecting the system power.

Five minutes after reconnecting power system the TAN was 11.28 mg.L^{-1}, however 12 hours later the concentration was above 125.00 mg.L^{-1}. As BFT includes confined aquatic animals, heterotrophic bacterium and other microbial species in the water, all of them in symbiotic process that it is responsible to remove ammonia from culture system (El-Sayed, 2021).

Therefore, the system requires heavy aeration to keep the substrates and microbial communities in suspension, as well to perform nitrification (oxidation) of ammonia into nitrite (NO_2) by bacteria of the genera *Nitrosomonas* and *Nitrosococcus,* which is further oxidized into nitrate (NO_3) by *Nitrobacter* and *Nitrospira* bacteria (SCHRAMM et al., 1999; HARGREAVES, 2006). Another hypothesis is that changes in the culture environment (aerobic to anaerobic) may have regulated the quorum sensing of the microbial communities in the water, favoring another group of bacteria (different from the nitrifying ones)

CONCLUSION

Thus, the most likely cause of fish mortality was the increase in TAN concentration, due to the lack of oxygen during the power failure, which compromised the nitrification process in the biofloc. This report suggests that in BFT, heterotrophic bacteria are more sensitive to a drop in oxygen supply than Nile tilapia, and points out the necessity to conduct studies to define lethal concentrations for bacteria in this system.

ACKNOWLEDGMENTS

The authors of this study acknowledge GUABI for financing the diets used; GF-AQUA for providing reagents for water analysis; and JSBombas for maintenance of air blowers.

REFERENCES

APHA - American Public Health Association. 2005. American Water Works Association, Water Pollution Control Association. Standard Methods for theExamination of Water and Wastewater, 21st ed. American Public Health Asso-ciation, Washington, DC, USA.

AVNIMELECH, Y. Carbon/nitrogen ratio as a control element in aquaculture systems. **Aquaculture**, v.176, p. 227–235, 1999 <https://doi.org/10.1016/S0044-8486(99)00085-X>

EBELING, J.M.; TIMMONS, M.B.; BISOGNI, J.J.. Engineering analysis of thestoichiometry of photoautotrophic, autotrophic, and heterotrophic removal ofammonia–nitrogen in aquaculture systems. **Aquaculture**, v. 257, p. 346-358, 2006. < https://doi.org/10.1016/j.aquaculture.2006.03.019>

EL-SAYED, Abdel-Fattah M. Use of biofloc technology in shrimp aquaculture: a comprehensive review, with emphasis on the last decade. **Reviews in Aquaculture**, v. 13, n. 1, p. 676-705, 2021. < https://onlinelibrary.wiley.com/doi/epdf/10.1111/raq.12494 >

HARGREAVES, JOHN A. Photosynthetic suspended-growth systems in aquaculture. **Aquacultural engineering**, v. 34, n. 3, p. 344-363, 2006. < https://doi.org/10.1016/j.aquaeng.2005.08.009 >

JATOBÁ, A.; BORGES, Y. V.; SILVA, F. A. BIOFLOC: sustainable alternative for water use in fish culture. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v. 71, n. 3, p. 1076-1080, 2019. < https://doi.org/10.1590/1678-4162-10309 >

NAYLOR, R.L.; GOLDBURG, R.J.; PRIMAVERA, J.H., *et al*. Effect of aquaculture on world fish supplies. **Nature**, v. 405, p. 1017–1024, 2000. < https://www.nature.com/articles/35016500>

SCHRAMM, A.; DE BEER, D.; VAN DEN HEUVEL, J. C.; OTTENGRAF, S.; AMANN, R. Microscale Distribution of Populations and Activities of *Nitrosospira* and *Nitrospira* spp. along a Macroscale Gradient in a Nitrifying Bioreactor: Quantification by In Situ Hybridization and the Use of Microsensors. **Applied and environmental microbiology**, v. 65, n. 8, p. 3690-3696, 1999. <https://journals.asm.org/doi/full/10.1128/AEM.65.8.3690-3696.1999>

SIDDIQUI, M. F.; RZECHOWICZ, M.; HARVEY, W.; ZULARISAM, A. W.; ANTHONY, G. F. Quorum sensing based membrane biofouling control for water treatment: a review. **Journal of Water Process Engineering**, v. 7, p. 112-122, 2015. < https://doi.org/10.1016/j.jwpe.2015.06.003>