ALLIANCE™
(https://www.globalseafood.org)

Responsible Seafood ADVOCATE

Health & Welfare

Water quality impacts on health and performance of fish and shrimp, Part 3: The nitrogenous compounds ammonia, nitrite and nitrate

6 July 2026

By Fernando Kubitza, Ph.D.

Effective monitoring and management of ammonia, nitrite and nitrate are essential in intensive aquaculture systems, especially in low-water exchange ponds

Part 3 of the impact of water quality on health and performance of farmed fish and shrimp covers the nitrogenous compounds ammonia, nitrite and nitrate. While water quality is widely acknowledged as critical to aquaculture success, many farmers continue to underestimate the harmful effects of marginal water conditions. Regular monitoring and proper management of key water quality parameters are essential to keep them within suitable ranges for the cultured species. Photo by Darryl Jory.

Ammonia (NH_3), nitrite (NO_2^-), and nitrate (NO_3^-) can accumulate and reach levels that impair the performance and health of aquatic animals and can even cause intoxication and death. Sub-lethal concentrations of ammonia and nitrite are common in intensive fish and shrimp production. The toxicity of these compounds depends on their concentrations, exposure time and interactions with environmental factors such as salinity, pH, dissolved oxygen, hardness and alkalinity. Understanding species-specific sensitivity, monitoring water quality and proper management practices are key to preventing problems associated with these nitrogenous compounds.

*Editor's notes: For references mentioned in the text without a link, contact the author directly. For the other parts of this series, see: **Part 1** (https://www.globalseafood.org/advocate/the-impact-of-water-quality-on-health-and-performance-of-farmed-fish-and-shrimp-part-1-dissolved-oxygen-and-carbon-dioxide/) and **Part 2** (https://www.globalseafood.org/advocate/water-quality-impacts-on-health-and-performance-of-fish-and-shrimp-part-2-ph-carbon-dioxide-alkalinity-hardness-and-the-water-buffering-system/).*

Origin and recycling of ammonia, nitrite and nitrate

The main sources of ammonia in aquaculture ponds are: a) the fecal excretion and the metabolism of protein (amino acids, having this name for containing an amino group (NH_2). Only 28 to 34 percent of feed protein is retained in fish and shrimp. Undigested protein and amino acids are excreted in feces. More than half of the absorbed amino acids are metabolized for energy, also generating ammonia, which must be quickly excreted from the blood or hemolymph, mainly through the gills; b) decomposition of protein/amino acids in organic wastes, such as decayed microalgae, uneaten feed, feces, shrimp exoskeleton, body mucus and organic fertilizers. Microbial decomposition occurs in the sediments of ponds and tanks; c) nitrogenous fertilizers containing ammonia, urea or nitrate (Fig. 1).

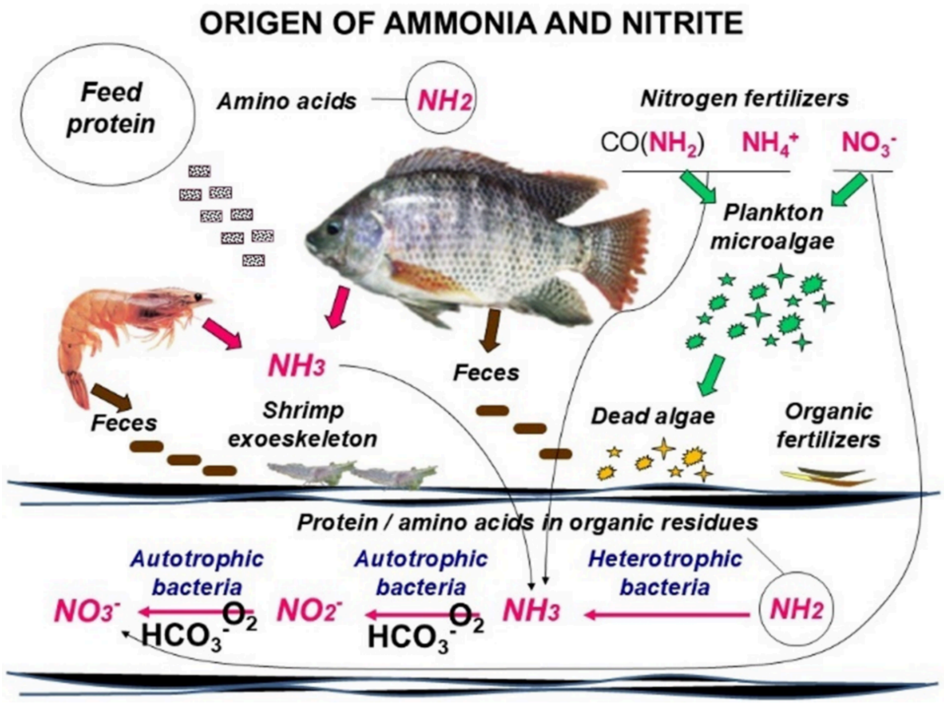

Fig. 1: Main sources of ammonia, nitrite and nitrate in intensive farming of fish and shrimp.

In green-water ponds, ammonia is quickly assimilated by phytoplankton. A minor fraction is oxidized to nitrite and nitrate by bacteria. In intensive fish and shrimp ponds at high feeding rates, ammonia production often surpasses phytoplankton and bacterial assimilation, requiring farmers attention. In recirculating aquaculture systems (RAS), ammonia mainly comes from metabolic excretion and decomposition of dissolved solids. Biofilters with nitrifying bacteria convert ammonia to nitrite and then nitrate. Although nitrate is less toxic, concentrations above 200–900 ppm can harm fish and shrimp. Therefore, biofilters must be properly designed to handle total ammonia or feed input. In biofloc systems (BFT), the bioflocs – aggregates of organic particles, and attached bacteria and other microorganisms – act similarly to RAS biofilters. Heterotrophic bacteria degrade organic waste and assimilate ammonia into microbial protein, while autotrophic bacteria oxidize ammonia to nitrite and nitrate.

Water pH regulates ammonia toxicity

Test kits measure total ammonia nitrogen (TAN) in water, the sum ammonium ion (NH_4^+, less toxic) and ammonia gas (NH_3, highly toxic). The share of NH_3 (toxic form) on TAN increases with the increase in water pH (Table 1). Ammonia alters nerve impulses and muscle contraction in fish and shrimp. Nervous disorders, muscle, highly toxic). The share of NH_3 (toxic form) on TAN increases with the increase in water spasms, and erratic swimming are common signs of ammonia intoxication. Gills become irritated and the animals experience difficulty breathing even with adequate oxygen in the water.

Kubitza, Water Quality, Table 1.xlsx

Show 10 entries

Search

	[1]Percent toxic ammonia (NH_3) on TAN at 28 degrees-C	
Water pH	**Freshwater 0 ppt**	**Saltwater 36 p**
6.5	0.22 percent	0.18 percent
7	0.71 percent	0.58 percent
7.5	2.2 percent	1.8 percent
8	6.6 percent	5.5 percent
8.5	18.4 percent	15.6 percent
9	41.7 percent	36.8 percent
9.5	69.2 percent	64.8 percent
10	87. 7 percent	85.4 percent

Showing 1 to 9 of 9 entries

Previous 1 Next

Table 1: Percent of toxic ammonia (NH3) on the total ammonia (TAN) in freshwater (0 ppt) and in salt water (36 ppt) at 28 degrees-C and different water pH. 1Ambient Water Quality Criteria for Ammonia in Saltwater - 1989, EPA 440/5-88-004.

Nitrite in water can exist as HNO_2 or NO_2^-. At pH values above 5.5, HNO_2 is almost absent. In fish and shrimp culture, where water pH typically ranges from 6.0 to 10.0, nitrite toxicity results exclusively from the absorption of NO_2^- through the gills. Nitrite binds to hemoglobin and hemocyanin, preventing these blood proteins from transporting oxygen from the gills to other tissues.

Commercial test kits for ammonia, nitrite and nitrate use colorimetric methods (Fig. 2) with accuracy suitable for aquaculture. When tested sample color matches or exceeds the highest value on the test color chart, the sample should be diluted with clean water (deionized or even rainwater) and retested until the tested sample color falls within the chart range. The final result must then be multiplied by the corresponding dilution factor.

Fig. 2: Examples of colorimetric test kits for ammonia, nitrite and nitrate.

Safe and toxic concentrations of ammonia, nitrite, and nitrate for fish and shrimp

Lethal concentrations of ammonia, nitrite, and nitrate that kill 50 percent of the animals after 96 hours of continuous exposure (referred to as LC_{50}-96h) have been determined for several species of fish and shrimp (Table 2).

Kubitza, Water Quality, Table 2.xlsx

Species	mg/L $N\text{-}NH_3$	mg/L $N\text{-}NO_2^-$	mg/L $N\text{-}NO_3^-$
Nile tilapia	1.4 - 2.6 (0.14)	8 - 338 (0.8)(1)	ND (500) (4)
Channel catfish	1.4 - 3.1 (0.14)	7.1 (0.7)	1,400 (140)
Common carp	1.13 - 1.30 (0.11)	20.0 (2.0)	1,075 (107)
Rainbow trout	0.08 - 0.9 (0.008)	0.24 – 11 (0.024)(1)	ND (< 80)(4)
Pacific white shrimp	0.6 - 2.8 (0.06)	5.7 - 15 (0.57)(1)	ND (220) (4)
		76 - 321 (7.6)(3)	
Black tiger shrimp	0.96 - 1.08 (0.10)	38 -171 (3.8)	1,450-2,320 (145)

Table 2: Lethal concentrations (LC50-96h) of ammonia (N-NH3), nitrite (N-NO2-) and nitrate (N-NO3-) for some freshwater fish and marine shrimp. Attention values of 10 percent LC50-96h are presented inside brackets.
(1) nitrite tolerance increases as chloride levels in the water rise. Lower tolerance occurs in waters with little chloride;
(2) salinities from 0.6 to 2 ppt. Nitrite tolerance increases with increasing water salinity;
(3) salinities from 15 to 35 ppt. Nitrite tolerance increases with increasing water salinity;

(4) ND = LC50-96h values not yet determined. The cautionary values inside brackets are suggested based on results from growth experiments with different nitrate levels.

Effect of ammonia on the performance and health of fish

For most warmwater farmed fishes, NH_3 of 0.1 to 0.2 mg/L (10 percent of the LC_{50}-96h value) can be considered as a warning concentration. Above these limits there could be gill irritation and damage, respiratory impairment, and, consequently, reduced growth and immunity.

Fig. 3: Catfish mortality due to ammonia toxicity in West Alabama (USA). Dense phytoplankton blooms elevate water pH, increasing the percentage of toxic ammonia (NH3) in water.

Toxic ammonia of 0.1 mg/L reduced weight gain of Nile tilapia by 28 percent (Table 3). Although tilapia can tolerate high ammonia concentrations, as seen in Table 2, toxic ammonia should not exceed 0.05 mg of NH_3/L. At 28 degrees-C, the value of 0.05 mg NH_3/L corresponds to a total ammonia of 7 mg/L at pH 7.0, 0.76 mg/L at pH 8.0 or 0.12 mg NH_3/L at pH 9.0.

Kubitza, Water Quality, Table 3.xlsx

Show 10 entries

Search

NH3 (mg/l)	Final weight (g)	Weight gain (g/fish)	Relative weight gain
0.004	37.7	18.7	100%
0.01	37.2	18.2	97%
0.05	36.4	17.4	93%
0.1	32.5	13.5	72%
0.15	26.9	7.9	42%

Showing 1 to 5 of 5 entries Previous 1 Next

Table 3: Effect of continuous exposure to increasing concentration of toxic ammonia (NH3 mg/l) on the final weight and weight gain of Nile tilapia. Initial weight of 19 g. Adapted from El-Sherif and El-Feky (2008).

No increase in mortality was observed by **Farmer et al. (https://doi.org/10.1080/08997659.2011.616836)** (2011) in juvenile channel catfish exposed to sublethal ammonia levels (0.43 mg $N–NH_3$/L) and challenged with the bacterium *Flavobacterium columnare*, as well as in juvenile Nile tilapia exposed to 0.37 mg $N–NH_3$/L and challenged with the bacterium *Streptococcus agalactiae*, as reported by **Evans et al.** (https://doi.org/10.1577/A05-032.1) (2006), compared to challenged fish that had not been previously exposed to ammonia. However, it is reasonable to believe that fish exposed to sublethal ammonia levels may be less tolerant to diseases, given the diversity of fish species and pathogens in aquaculture operations.

Effects of ammonia on the performance, health, and survival of marine shrimp

Marine shrimp are more sensitive to ammonia during younger life stages and in low-salinity waters. Ammonia LC_{50}-24h was determined by **Cobo et al.** (https://doi.org/10.1111/j.1365-2109.2012.03248.x) (2012) for Zoea 1 (0.6 mg NH_3/L), Zoea 2 (1.5 mg/L), Zoea 3 (2.4 mg/L), Mysis 1 (2.8 mg/L), Mysis 2 (2.5 mg/L) Mysis 3 (2.6 mg/L), PL-1d (1.9 mg/L) and PL-22 mm (2.8 mg/L). Ammonia LC_{50}-96h increased as salinity increased. For 22 mm *Penaeus vannamei*, **Lin and Chen** (https://doi.org/10.1016/S0022-0981(01)00227-1)(2001) reported 1.2 mg NH_3/L at salinity of 15 ppt, and about 1.6 mg/L at 25 e 35 ppt. For 22 mm *Litopenaeus schimitti*, **Barbieri** (https://doi.org/10.1016/j.aquaculture.2010.06.009)(2010) reported 0.7 mg NH_3/L at 5 ppt, 0,9 at 20 ppt and 1.2 mg/L at 35 ppt.

Toxic ammonia concentrations starting from near 0.1 mg/L resulted in reduced growth of *Penaeus chinensis* (Table 4). The growth of shrimp after 10 days of continuous exposure to 0.5 and 0.7 mg/L toxic ammonia was only 47 percent of the growth observed in animals at the control group (zero ammonia). Therefore, for marine shrimp it is recommended to set a threshold limit of 0.1 mg NH_3/L.

Kubitza, Water Quality, Table 4.xlsx

Show 10 entries Search

Total ammonia (TAN-mg/L)	Toxic ammonia (NH_3 – mg/L) at pH 8.4	10-d growth in length (mm)	Relative growth (%)
Control	Nearly zero	11.5	100
0.6 to 2	0.07 to 0.22	7	61
5.0 a 7 mg/l	0.55 to 0.77	5.4	47
14.0 mg/l	1.5	2.6	23

Showing 1 to 4 of 4 entries Previous 1 Next

Table 4: Growth of 40-mm *Penaeus chinensis* kept for 10 days under different ammonia concentrations in water at pH 8.4 (Adapted from Chien, 1992).

P. vannamei (9 grams weight) had a significant reduction in hemocyte count and in the activity of the enzymes PO (phenoloxidase) and SOD (superoxide dismutase) when exposed for 48 hours to sublethal toxic ammonia concentrations of 0.1 or 0.5 mg $N–NH_3$/L (Table 5). Hemocytes and the enzymes PO and SOD play an important role in the shrimp's defense mechanisms and resistance to pathogens.

Kubitza, Water Quality, Table 5.xlsx

		Hemolymph		Hepatopancreas		Survival	
		(U/mg protein)		(U/mg protein)		(%)	
$N-NH_3$	**THC**	**PO**	**SOD**	**PO**	**SOD**	**5 ppt**	**30 ppt**
0.001 mg/l	78	0.68	1.45	17.8	7.1	100%	100%
0.1 mg/l	43	0.46	0.95	10.4	4.7	100%	100%
0.5 mg/l	32	0.44	0.7	7.2	4	86%	95%

Table 5: Total hemocyte count (THC), activity of phenol oxidase (PO) and superoxide dismutase (SOD) in the hemolymph and in the hepatopancreas, and survival of *P. vannamei* after 48-h exposure to different concentrations of toxic ammonia (expressed in mg N-NH3/L). Adapted from Jia et al. 2017.

P. vannamei kept in water with total ammonia concentrations from 5 to 22 mg/L (toxic ammonia from 0.28 to 1.14 mg $N-NH_3$/L) were immune-suppressed and presented higher mortality (40 to 50 percent) after an experimental infection with *Vibrio alginolyticus*, compared to 20 to 23 percent mortality for shrimp kept in water with 0 to 0.06 mg $N-NH_3$/L. **Liu and Chen** (https://doi.org/10.1016/S1050-4648(03)00113-X)(2004) reported that shrimp kept at 22 mg/L total ammonia (1.14 mg $N-NH_3$/L) and not injected with *V. alginolyticus* showed zero mortality.

In intensive shrimp pond aquaculture, the total ammonia concentration rarely exceeds 3 mg/L. However, in ponds with high feeding rates (above 150 to 200 kg of feed/ha/day) and low water renewal, total ammonia concentrations can reach 6 to 8 mg/L. At these concentrations, shrimp will certainly be exposed to toxic ammonia of at least 0.33 to 0.44 mg/L in saltwater with pH 8.0. If the pH increases to 9.0 due to photosynthesis, toxic ammonia concentrations could exceed 2.3 mg/L. Such high levels of NH_3 not only harm growth but can also reduce shrimp resistance to pathogens and even cause death.

Effects of nitrite on the performance, health, and survival of fish

Nitrite entering the blood binds to hemoglobin and oxidizes iron ($Fe^{2+} \rightarrow Fe^{3+}$), forming methemoglobin. In shrimp, hemocyanin likely undergoes a similar oxidation of copper. Once bound to nitrite, hemoglobin and hemocyanin can no longer transport oxygen to tissues and organs. Nitrite toxicity in fish can be assessed by methemoglobin levels. According to Boyd (Boyd, C. E. 1990. Water Quality in Ponds for Aquaculture. Auburn, AL: Auburn University, Alabama Agricultural Experiment Station. 482 pp.), channel catfish exposed for 24 h to 1 mg $N–NO_2^-$/L showed 21 percent methemoglobin, rising to 60 percent at 2.5 mg $N–NO_2^-$/L. Respiratory stress may occur above 5 percent, clear toxicity at 20–30 percent, and mortality above 50 percent methemoglobin, especially under low oxygen. Methemoglobin also causes “chocolate blood,” visible in the gills or blood from a cut in the caudal peduncle. In freshwater, chronic exposure to 0.3–0.5 mg/L nitrite can reduce fish growth and disease resistance. Chloride ions reduce nitrite toxicity, so tolerance increases with salinity. Toxic levels for tilapia, other farmed fish, and marine shrimp are shown in Tables 6 and 7.

Nile tilapia is highly tolerant to nitrite. In 4-gram fish, LC_{50}-96h increased from 81 to 338 mg/L $N-NO_2^-$ as chloride rose from 6 to 375 mg/L (Table 6), because chloride competes with nitrite for gill receptors and reduces uptake. In intensive ponds with high feeding and low water exchange, adding sodium chloride (sea salt) can help prevent toxicity. Recommended $Cl^-:NO_2^-$ ratios are 6–10:1 (some suggest 20:1 for safety). Salt dosage can be estimated using this equation proposed by Boyd (1991): Salt (g/m^3) = [(6–10) × (NO_2^- mg/L – Cl^- mg/L)] ÷ 0.6. For example, if nitrite may reach 5 mg NO_2^-/L in freshwater, about 83 g salt/m³ is needed; a 1,500 m³ pond would require ~125 kg salt, raising salinity by only 0.08 ppt, enough to reduce nitrite risk.

Kubitza, Water Quality, Table 6.xlsx

		LC_{50}-96h (mg/L)			
Species	**Wt. g**	**NO_2^-**	**$N-NO_2^-$**	**Cl^-**	**References**
Nile tilapia	4.4	270	81	6	Atwood et al 2001
	90.7	27	8	ND	Atwood et al 2001
	4.4	1,127	338	375	Atwood et al 2001
	1.8	94	28.2	35	Yanbo et al 2006
	1.8	149	44.7	70	Yanbo et al 2006
Channel catfish		24	7.1	ND	Palachek and Tomasso 1984
Largemouth bass		467	140.2	ND	Palachek and Tomasso 1984

Table 6: Lethal concentrations (LC50-96h) of nitrite (in mg/L of NO_2^- or mg/L of $N-NO_2^-$) for different cultured fish species. Chloride concentrations in the water (Cl^- in mg/L). Consider as a safe concentration a value equal to 10 percent of the 96-h LC50. For example, for Nile tilapia, this ranges from 0.3 to 112 mg/L of NO_2^-, depending on water salinity. For Tambaqui, the safe level is 0.6 mg/L of NO_2^-.

Effects of nitrite on the performance, health, and survival of shrimp

For the marine shrimp *L. vannamei*, LC_{50}-96h values are < 12 mg N-NO_2^-/L at 2 ppt salinity and higher than 75 mg N-NO_2^-/L above 15 ppt salinity (Table 7). Using 10 percent of LC_{50}-96h as a safe level, warning thresholds range from 0.6 mg N-NO_2^-/L (≤ 1 ppt) to 32 mg N-NO_2^-/L (35 ppt). Higher chloride concentrations reduce nitrite absorption, so problems are rare above 20 ppt, but common in low-salinity systems, especially in deeper ponds with anaerobic sediments and poor circulation, and in RAS or BFT systems at 2–5 ppt.

Kubitza, Water Quality, Table 7.xlsx

Salt (ppt)	Weight (g)	LC50-96h mg N-NO2-/L	Attention limit mg N-NO2-/L	References
0.6	4.4	5.7	0.6	Ramírez-Rochín et al 2017
1	4.4	7	0.7	
2	4.4	12.4	1.2	
10	0.7	8.4	0.8	Sowers et al 2004
2	0.2	8.9	0.9	Gross et al 2004
3	0.6	15.2	1.5	Wang et al 2006
15	3.9	76.5	7.6	Lin and Chen (2003)

Table 7: Nitrite lethal concentrations (LC50-96h) and attention limits (considered here as 10 percent of the LC50-96h) for the Pacific white shrimp (*P. vannamei*) of different weights and at different water salinities (Salinity in ppt or g/L).

Furtado et al. (https://doi.org/10.1080/10236244.2016.1163837) (2016) reported that sublethal nitrite concentrations can cause severe reduction in growth and survival of marine shrimp. In water with 5 mg/L or higher N-NO_2^- *P. vannamei* had lower hemocyte counts and reduced phenoloxidase – PO (two key components of immune response) compared to shrimp exposed to 1 mg or less N-NO_2^-/L, according to **Tseng and Chen** (https://doi.org/10.1016/j.fsi.2004.04.010) (2004). In the same study, shrimp injected with *Vibrio alginolyticus* and transferred to tanks with 5 mg/L or higher N-NO_2^- had higher cumulative mortality post-infection compared to shrimp transferred to water with up to 1 mg/L N-NO_2^-.

"**Land use for aquaculture production (https://www.globalseafood.org/advocate/land-use-for-aquaculture-production/)**"

Effects of nitrate on the performance, health, and survival of fish and shrimp

Nitrate (NO_3^-) is far less toxic than ammonia or nitrite. For most fish and crustaceans, ≤25 mg N-NO_3^-/L is acceptable, while >100 mg N-NO_3^-/L requires attention. Nile tilapia is highly nitrate-tolerant, but juveniles exposed to 1,000 mg N-NO_3^-/L showed 29 percent lower weight gain, 56 percent lower feed efficiency, and increased blood nitrite and methemoglobin compared with fish reared at ≤500 mg/L. Researchers concluded nitrate should remain below 500 mg N-NO_3^-/L in intensive tilapia RAS. Safe and lethal levels for fish and shrimp are listed in Table 2. Rainbow trout reared at 80–100 mg N-NO_3^-/L did not show reduced growth but displayed abnormal swimming behavior compared with fish kept at 30 mg/L.

Pacific white shrimp exposed to 400–900 mg N-NO_3^-/L showed reduced growth and survival, antenna shortening, hepatopancreas lesions, and gill abnormalities (Table 8). Increasing salinity from 2 to 18 ppt reduced nitrate impacts at 440 mg/L. Similarly, 150–600 mg N-NO_3^-/L in BFT systems caused gill and hepatopancreas damage and reduced growth, feed efficiency, and survival of *P. vannamei* (Table 9).

Kubitza, Water Quality, Table 8.xlsx

Show 10 entries

Search

mg/l N-NO_3^-	Survival (percent)	Final wt. (g)	Antenna length (cm)
35	87	9.3	8.5
220	87	8.7	7.2
435	64	7.5	5.1
910	15	5	2

Showing 1 to 4 of 4 entries

Previous 1 Next

Table 8: Survival, final average weight, and antenna length of marine shrimp *P. vannamei* reared for 42 days in a biofloc system with 11 ppt salinity under different nitrate concentrations (Kuhn et al. 2010).

Kubitza, Water Quality, Table 9.xlsx

Show 10 entries

Search

mg/L N-NO_3^-	Survival (percent)	Final wt. (g)	FCR	Antenna length (cm)
75	100	6.07	1.5	5.68
150	87	5.97	1.6	4.86
300	77	4.89	3	2.52

600	71	3.94	4.34	2.03

Showing 1 to 4 of 4 entries

Previous 1 Next

Table 9: Survival, final average weight, feed conversion, and antenna length of marine shrimp *P. vannamei* reared for 42 days in water with different nitrate concentrations. Biofloc system, salinity 23 ppt, initial average weight 1.3 g (adapted from Furtado et al. 2015).

Management practices to prevent problems with nitrogenous compounds

Ammonia, nitrite, and nitrate must be closely monitored in intensive fish and shrimp systems. In intensive ponds with high feeding rates, ammonia and nitrite should be tested weekly. In recirculating aquaculture systems (RAS) and biofloc technology (BFT), they should be checked every other day until stable, then once or twice weekly. Nitrate should be measured weekly. In RAS, test before and after the biofilter or plant beds to evaluate nitrification efficiency.

General prevention practices include the following: use of high-quality, digestible feeds and avoid overfeeding; monitor and correct water alkalinity; ensure adequate aeration and water circulation; and increase chloride with salt, when possible, to reduce nitrite toxicity.

In intensive ponds: keep biomass and feeding within safe limits compatible to mechanical aeration and water-exchange capacity; control phytoplankton blooms (especially cyanobacteria) to avoid the occurrence of higher pH and oxygen deficit. Maintain night aeration and daytime water circulation using mechanical aerators. In freshwater ponds with low exchange, add salt to raise chloride; and limit the use of nitrogen fertilizers or manure.

In RAS: respect safe feeding rates; ensure efficient solid removal; design biofilters with enough surface area to oxidize all ammonia; maintain adequate oxygen, pH, and alkalinity for nitrifying bacteria; add chloride (salt or calcium chloride) to prevent nitrite toxicity; and keep nitrate below 100 mg NO_3^--N/L using water exchange, denitrification, or aquatic plants.

In BFT systems: add carbon sources (e.g., molasses, sugar, rice bran, wheat flour) as needed to stimulate initial biofloc formation and reduce TAN; allow microbial communities to mature before full feeding; keep flocs in suspension; monitor and correct alkalinity and pH; control excess solids with settling tanks; reuse mature water for stability; increase chloride to prevent nitrite toxicity; and maintain nitrate below 100–200mg NO_3^--N/L through exchange, denitrification, or plant uptake.

Fig. 4: Biofloc system: regular monitoring of ammonia and use of carbon sources such as molasse, crystal sugar or rice bran helps to stimulate floc formation and reduce total ammonia nitrogen.

Perspectives

Effective monitoring and management of ammonia, nitrite, and nitrate are essential in intensive aquaculture systems – especially in low-exchange ponds and in RAS or BFT. Maintaining proper water quality prevents growth losses, reduced feed efficiency, disease outbreaks and mortality associated with elevated nitrogenous compounds.

Author

FERNANDO KUBITZA, PH.D.

Jundiaí, São Paulo, Brazil
Dr. Fernando Kubitza is a Brazilian aquaculture specialist, founder and director of Acqua Imagem Services in Aquaculture (www.acquaimagem.com.br), a 26-years old company leading on aquaculture projects, training and technical support in Brazil.

fernando@acquaimagem.com.br (mailto:fernando@acquaimagem.com.br)