Environmentally friendly production of marine shrimp *Penaeus vannamei* in super intensive systems in the state of Virginia

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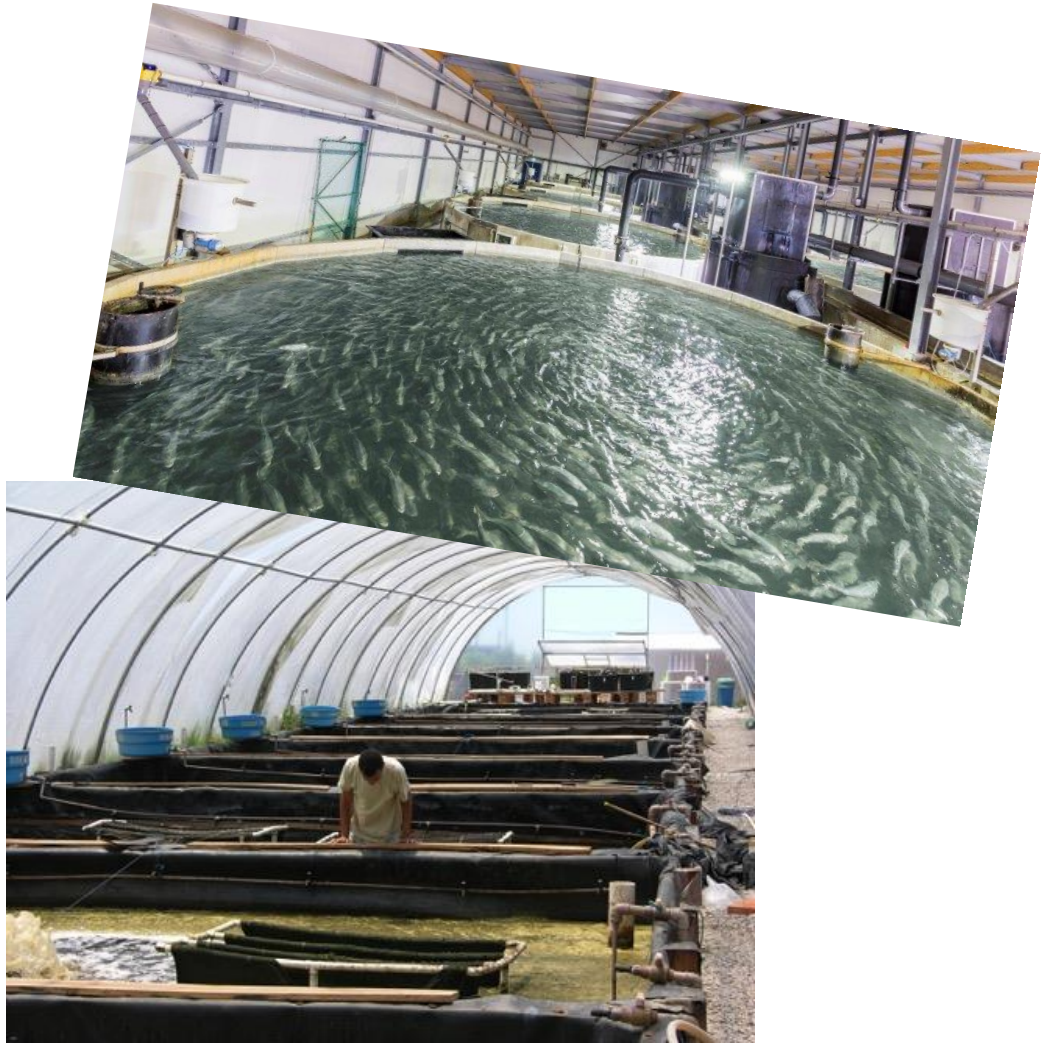
Introduction

- Currently, aquaculture is seeking biosafe systems with less impact on the natural environment.
- In this way, systems such as the Recirculating Aquaculture System (RAS) and the biofloc system (BFT) can combine sustainability with increased production.

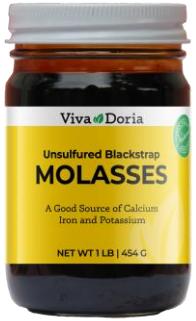


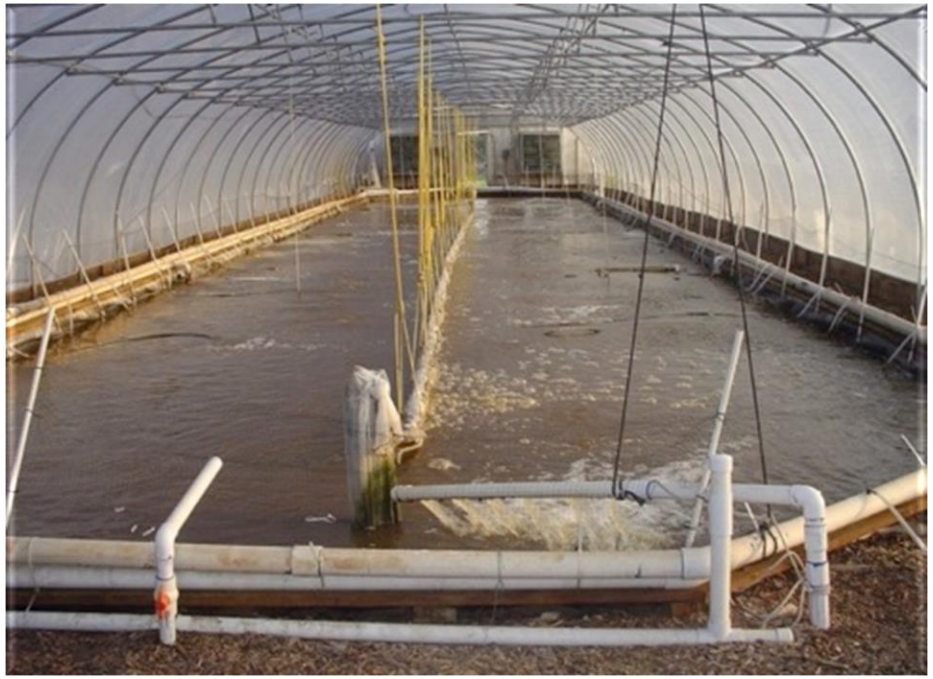
- RAS is characterized by a controlled environment;
- Removal of animal metabolites and organic matter residues;
- Mechanical and/or biological filtration;
- Provides high water reuse;
- Improves waste management, reduces water use and provides nutrient cycling.

Ahmed et al. (2021)

BFT system

- Microbial-based system;
- Organic carbon source use;
- Stimulates the growth of heterotrophic and nitrifying bacteria;
- Immobilizes ammonia produced in the system;
- These groups of bacteria acts in the cycling of nitrogen in the system;
- Tansformation of nitrogen in water into microbial protein.



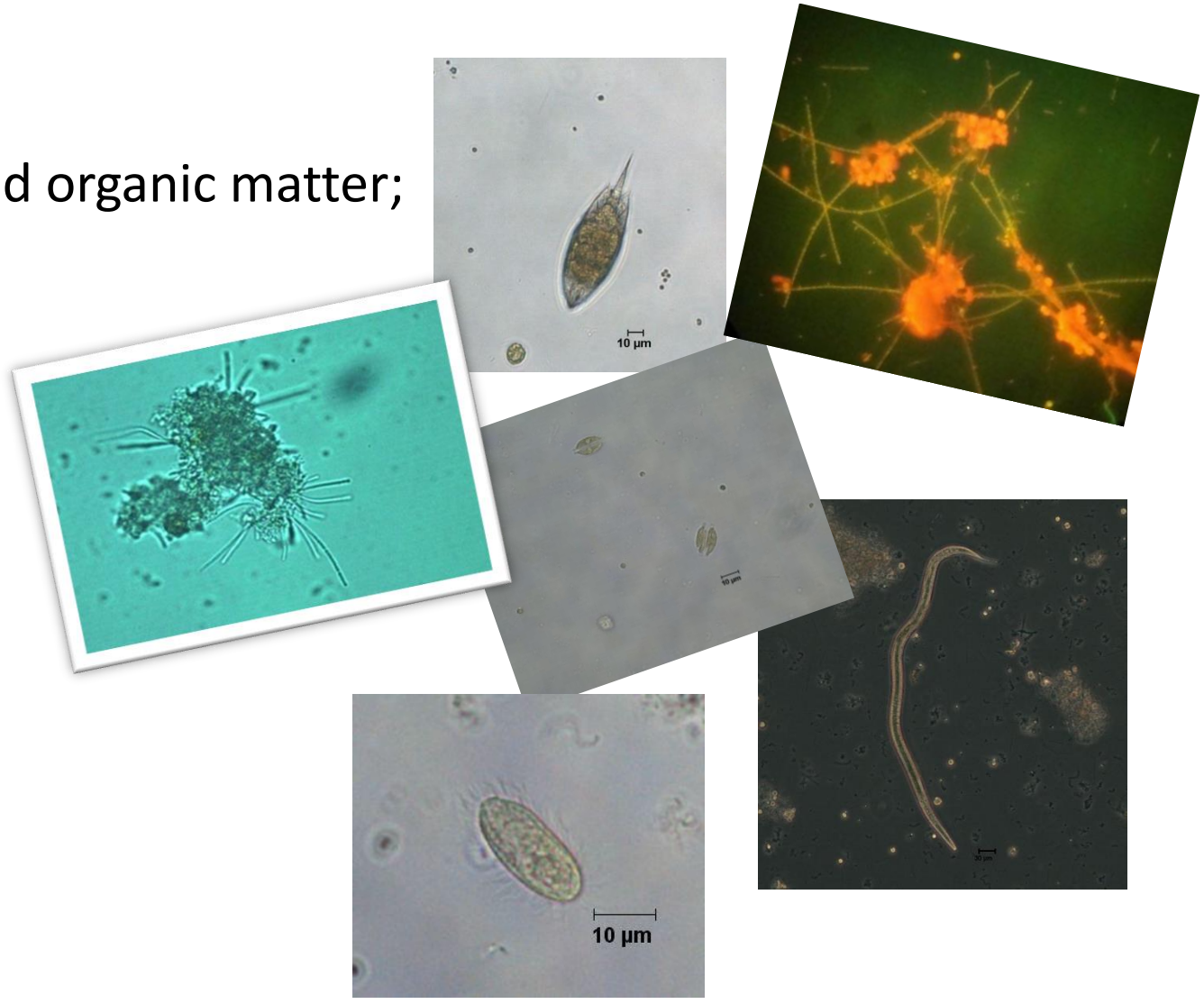


Bioflocs are grown in the system

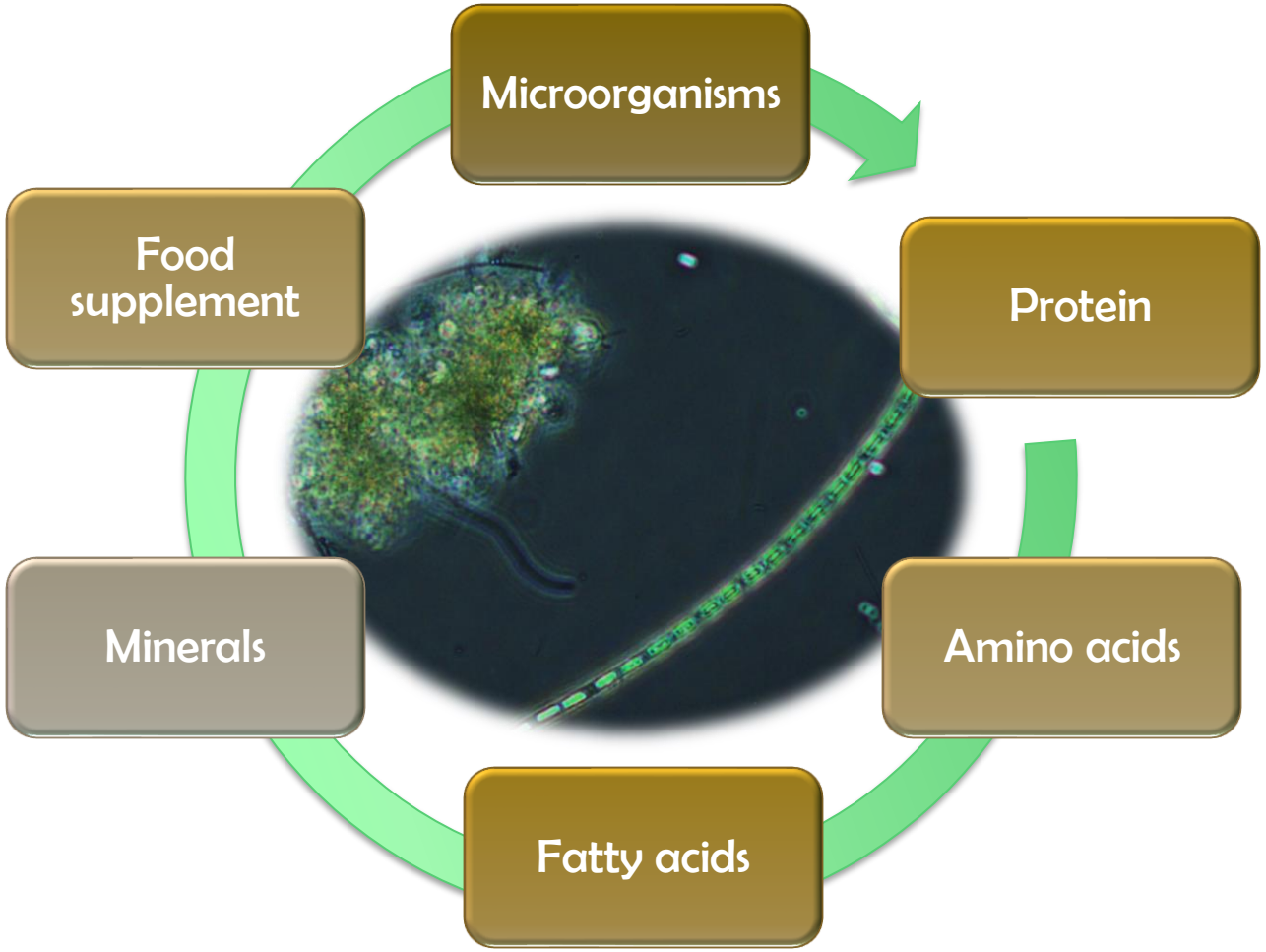
- Composed by microorganisms and organic matter;
- They maintain system stability.

BFT system provides

- High stocking densities;
- Reduced water use;
- No effluent discharge;
- Small areas;
- Increased biosecurity.



Biofloc



Tacon et al. (2002); Burford et al. (2004); Wasielesky et al. (2006)

2 trials

- Virginia Seafood Agricultural Research and Extension Center (VSAREC), Hampton.

Trial 1

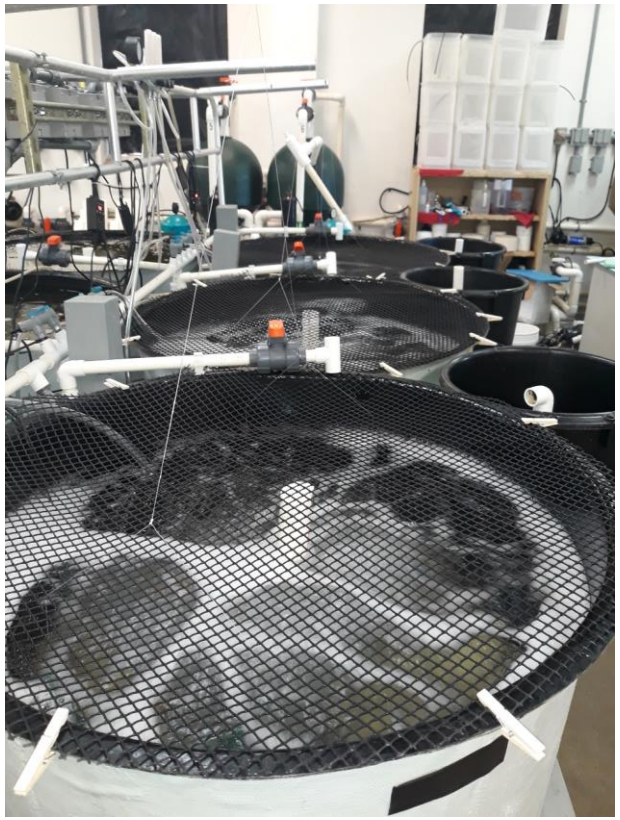
Evaluate the influence of the addition of copepod *Apocyclops panamensis* on the culture of *Penaeus vannamei* reared in a BFT system.

Dariano Krummenauer, Steve Urick, Caio A. Miyai, Flávia Banderó Höffling, José Maria Monserrat, Abdelnaser Bayoumy, Reza Ovissipour, and Michael Schwarz.

- 60 day-trial;
- *Penaeus vannamei* (0.056 ± 0.003 g);
- Stocking density: 500 shrimp m^{-3};
- *Apocyclops panamensis* (5.0 mL^{-1});
- Nine circular tanks 300 L.

Treatments

- T1 – Clear Water + Copepod;
- T2 – BFT+ Copepod;
- T3 - BFT without Copepod.



- Shrimp were fed with a commercial diet (Zeigler Bros);
- Copepod were fed with Rotigrow Plus Algal Blend (Reed Mariculture);
- BFT Treatments: No water exchange;
- CW Treatment: 100% of Water exchange.

Water quality

Daily

- Temperature, Salinity, Dissolved oxygen, and pH.

Every three days

- Total ammonia nitrogen (TAN);
- Nitrite nitrogen (NO_2^--N);
- Nitrate nitrogen (NO_3^--N).

Once a week

- Alkalinity;
- Total suspended solids (TSS);
- Settleable solids (SS).

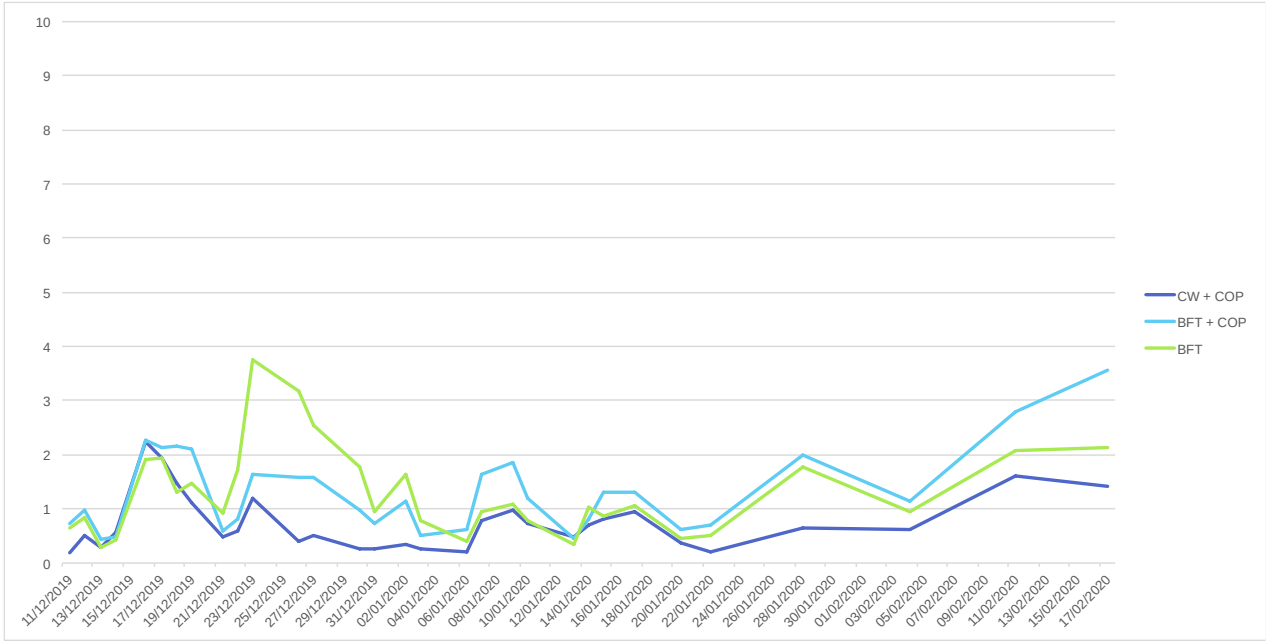
Results and discussion

Water quality

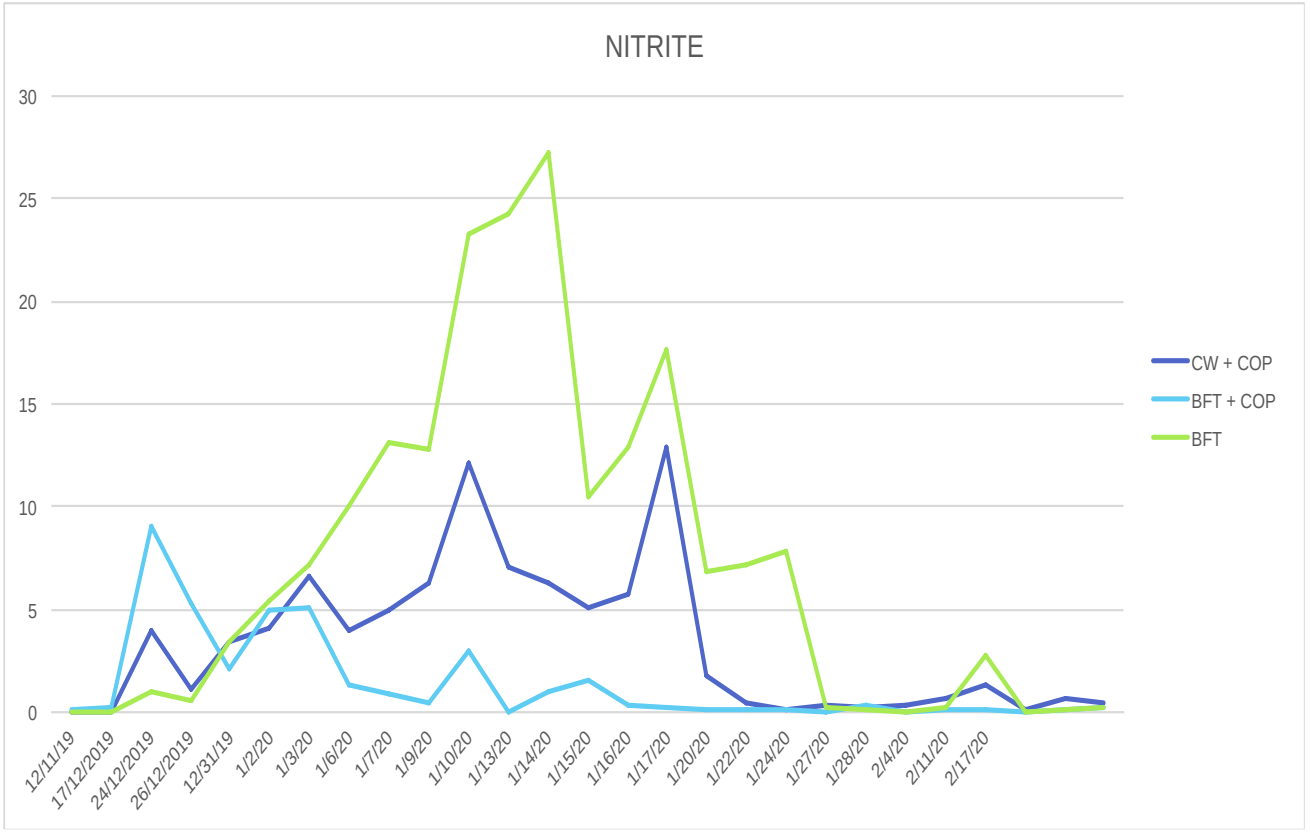
- Control of TAN in all treaments.

Clear water

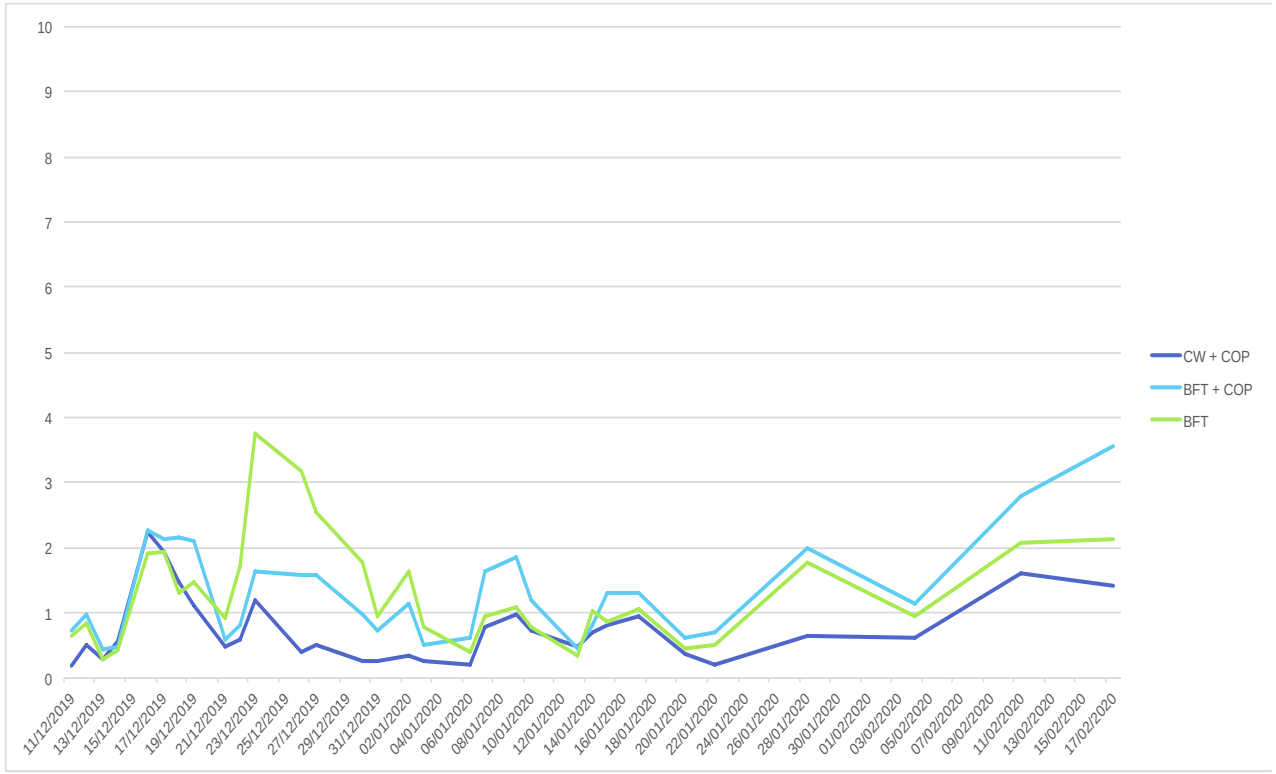
- TAN control due to daily water changes.



- Treatments with the addition of copepods provided better nitrite control.
- The presence of copepods in the System may have influenced the microbial composition of the system.



- Gradual accumulation of nitrate;
- Treatment where BFT was used;
- Last weeks of culture;
- Commonly reported pattern in shrimp farming with BFT.



Shrimp growth

Treatment	Final Weight (g)	WGR (g)	Yield (Kg/m^3)	Survival (%)	FCR
CW + COP	11.82±1.56	2.42±0.41	5.07±0.14	91.25±4.57	1.20
BFT + COP	11.85±2.08	2.38±0.17	4.67±0.86	83.54±6.53	1.30
BFT	11.74±2.12	3.13±0.30	4.23±0.93	74.14±4.57	1.44

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Conclusion

- The copepod addition provided better fixation of nitrifying bacteria resulting in a better control of nitrogenous compounds.

- Addition of copepods improved feed use, since FCR was lower in treatments where copepods were supplemented.

Trial 2

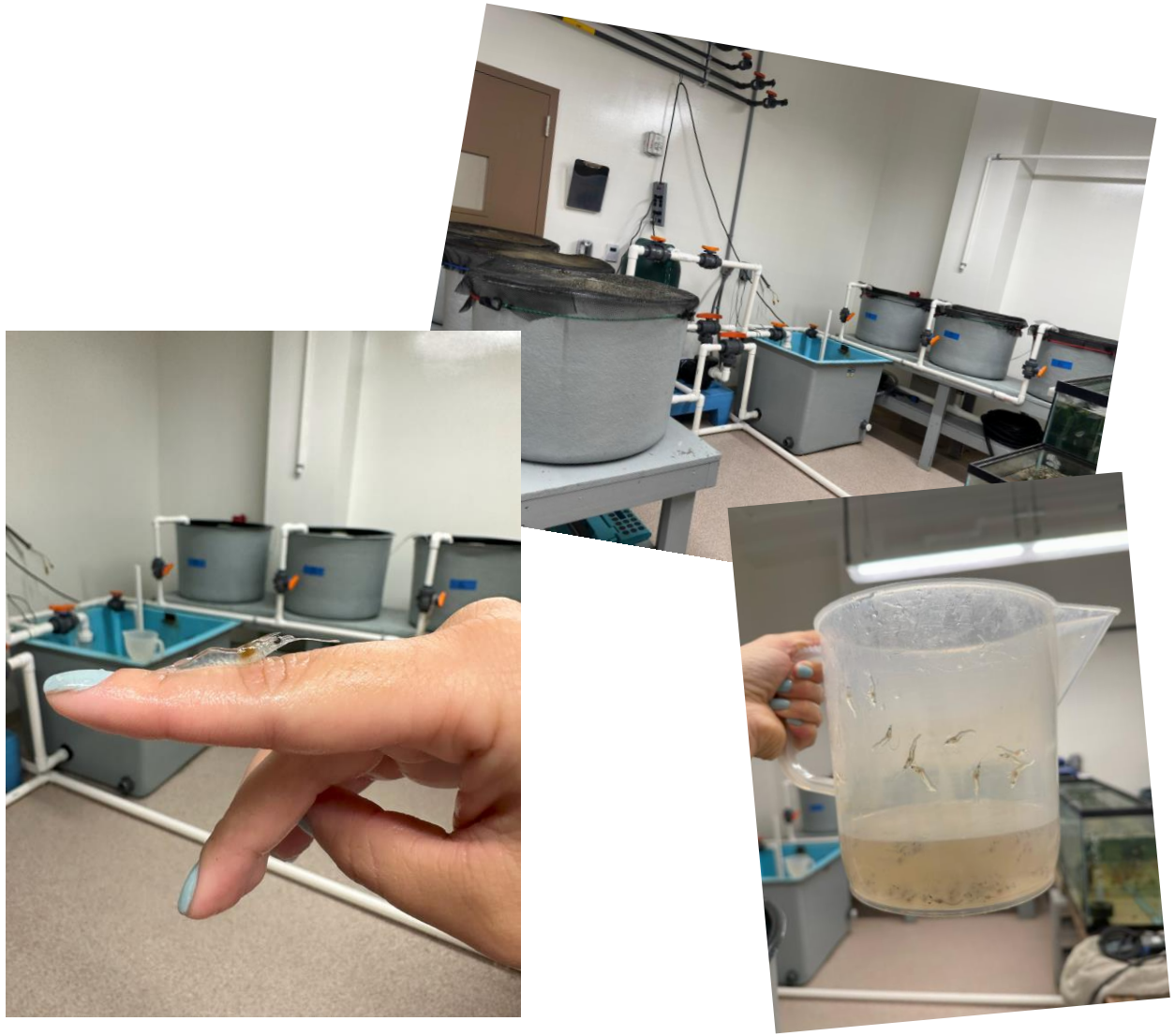
Evaluate the growth of *Penaeus vannamei* reared in a BFT and RAS system

Bianca Ramiro, Steve Urick, Ethan McAlhaney, Taozhu Sun, Otávio Augusto Pimentel, Jonathan van Senten, Michael Schwarz, and Dariano Krummenauer.

- 68 day-trial;
- *Penaeus vannamei* (0.102 ± 0.04g);
- Stocking density: 500 m^{-3};
- Six circular tanks 100 L.

Treatments

- T1 - BFT;
- T2 - RAS.



- Shrimp were fed with a commercial diet (Zeigler Bros);
- BFT: water changes between 20 and 30% of the volume of the experimental unit were performed to maintain the concentration of nitrogen compounds within the safe level for the species;
- RAS: Backwash three times a week. Replace the sump with water with a salinity close to 30 g L^{-1}.

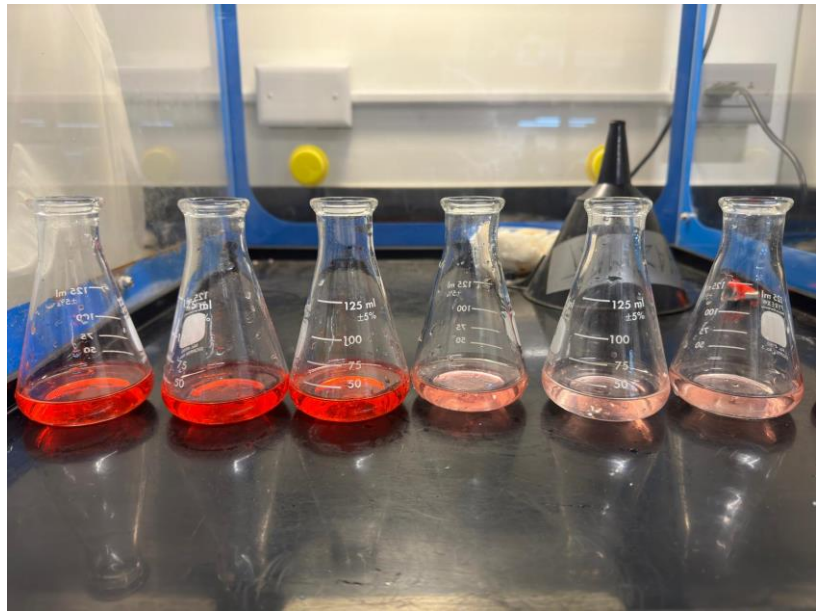
Water quality

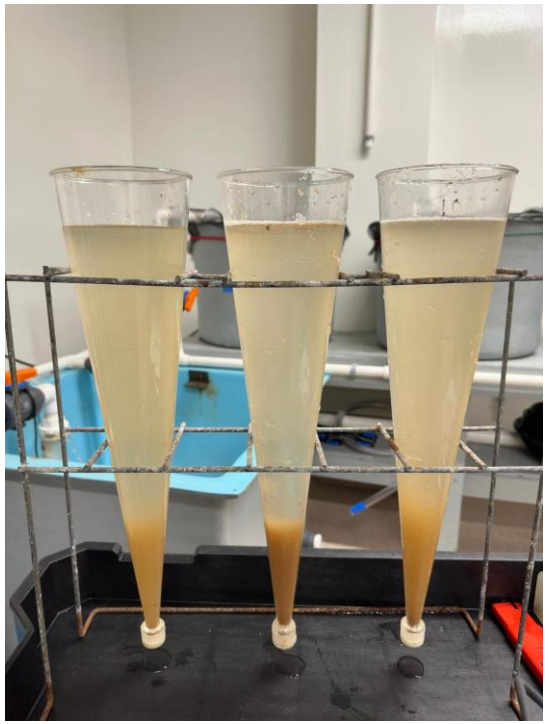
Daily

- Temperature, salinity, dissolved oxygen, and pH;
- Total ammonia nitrogen (TAN);
- Nitrite nitrogen (NO_2^--N).

Once a week

- Nitrate nitrogen (NO_3^--N);
- Alkalinity;
- Total suspended solids (TSS);
- Settleable solids (SS).

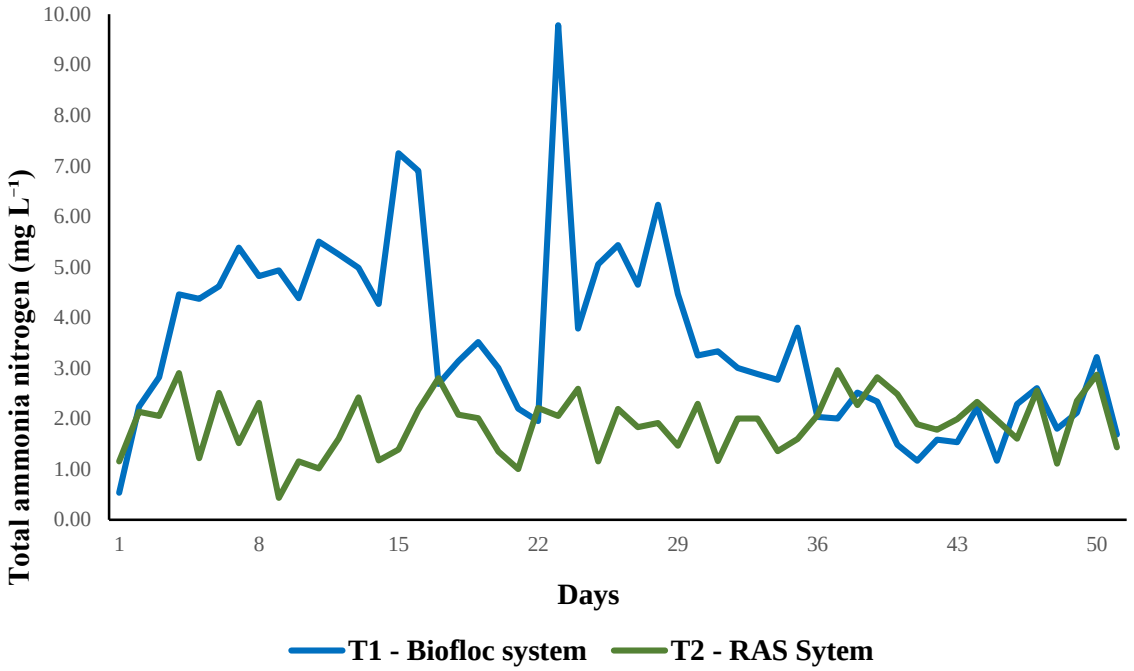




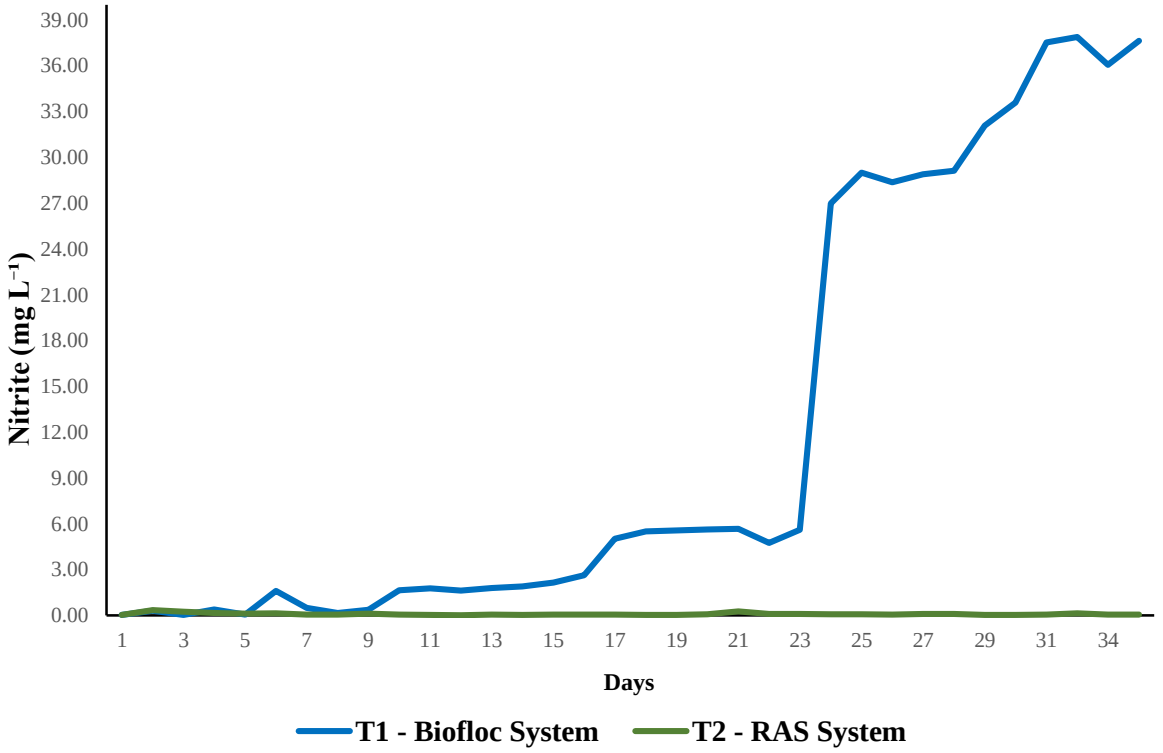
Results and discussion

Water quality

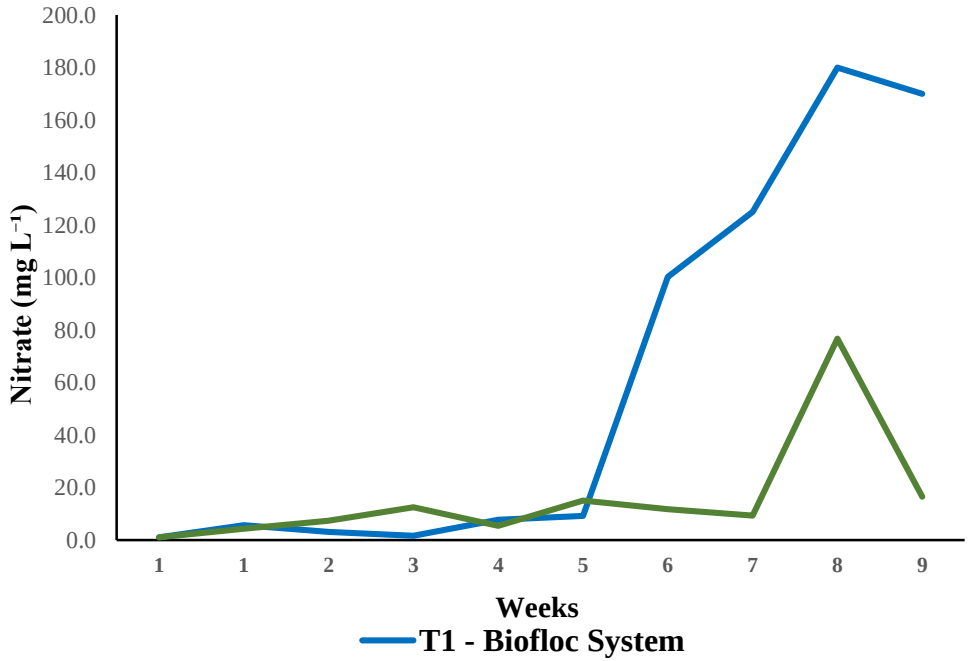
- TAN control was better in RAS;
- TAN control in the BFT treatment was observed from day 20 of the experimental time;
- Establishment of the ammonium oxidizing bacteria (AOB) community.



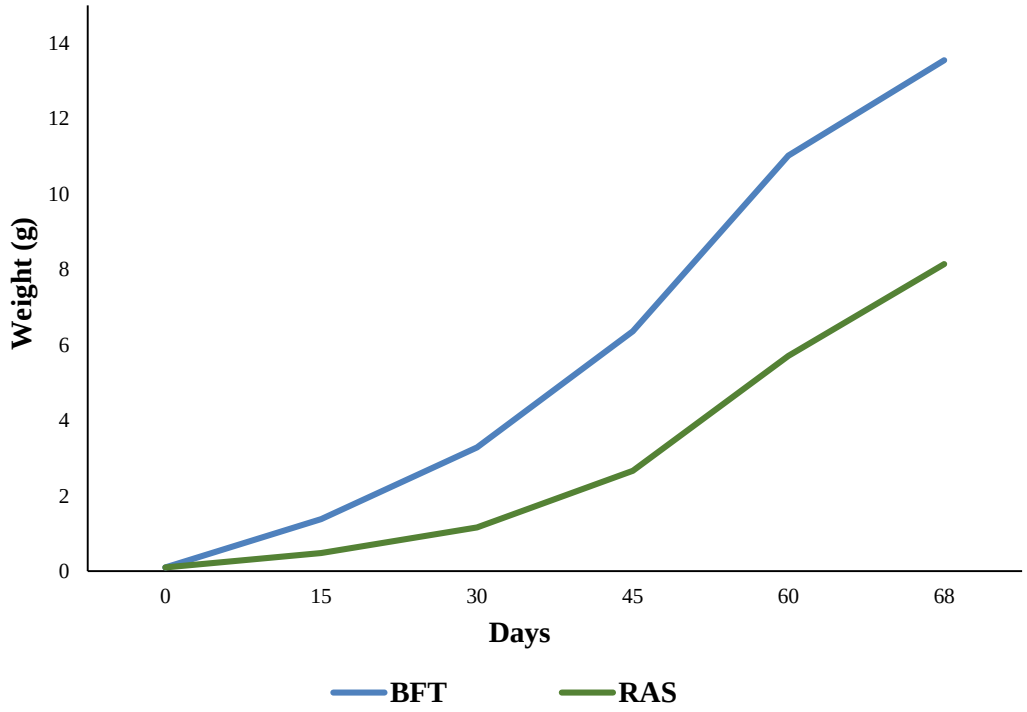
- Establishment of AOB confirmed with the increase in nitrite from the 20th of the trial;
- No nitrite control was observed throughout the trial;
- RAS: nitrite remained below 1 mg L^{-1}.

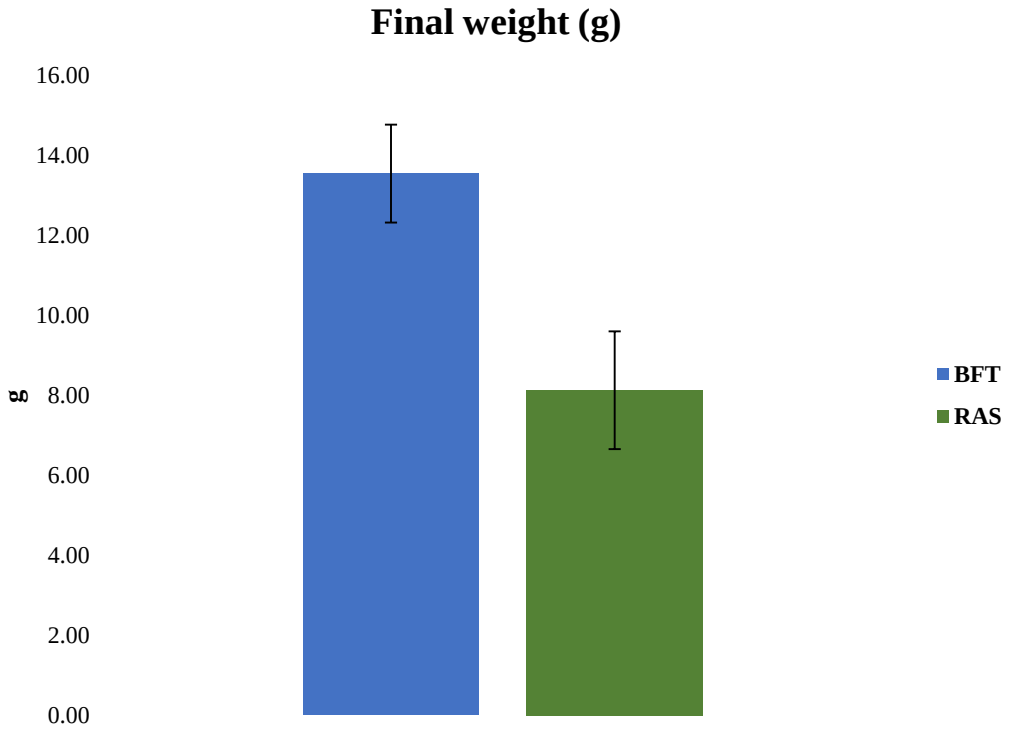


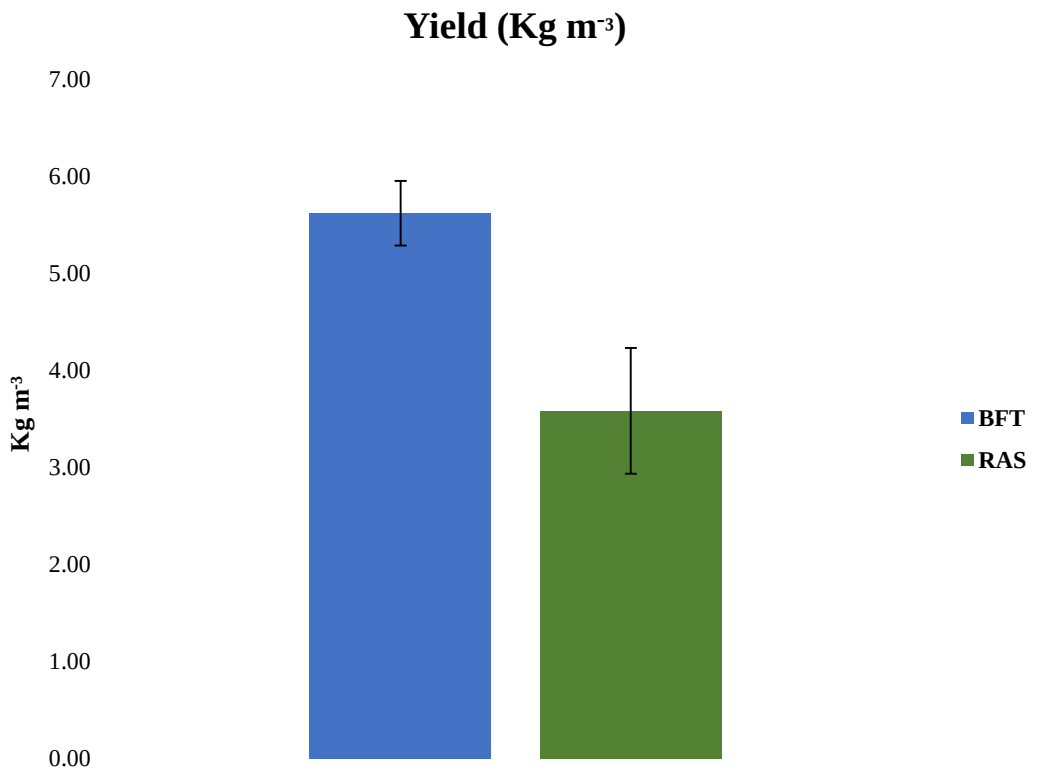
- Increasing pattern of nitrate in BFT treatment;
- Low nitrate concentrations in the RAS are explained by backwashing.

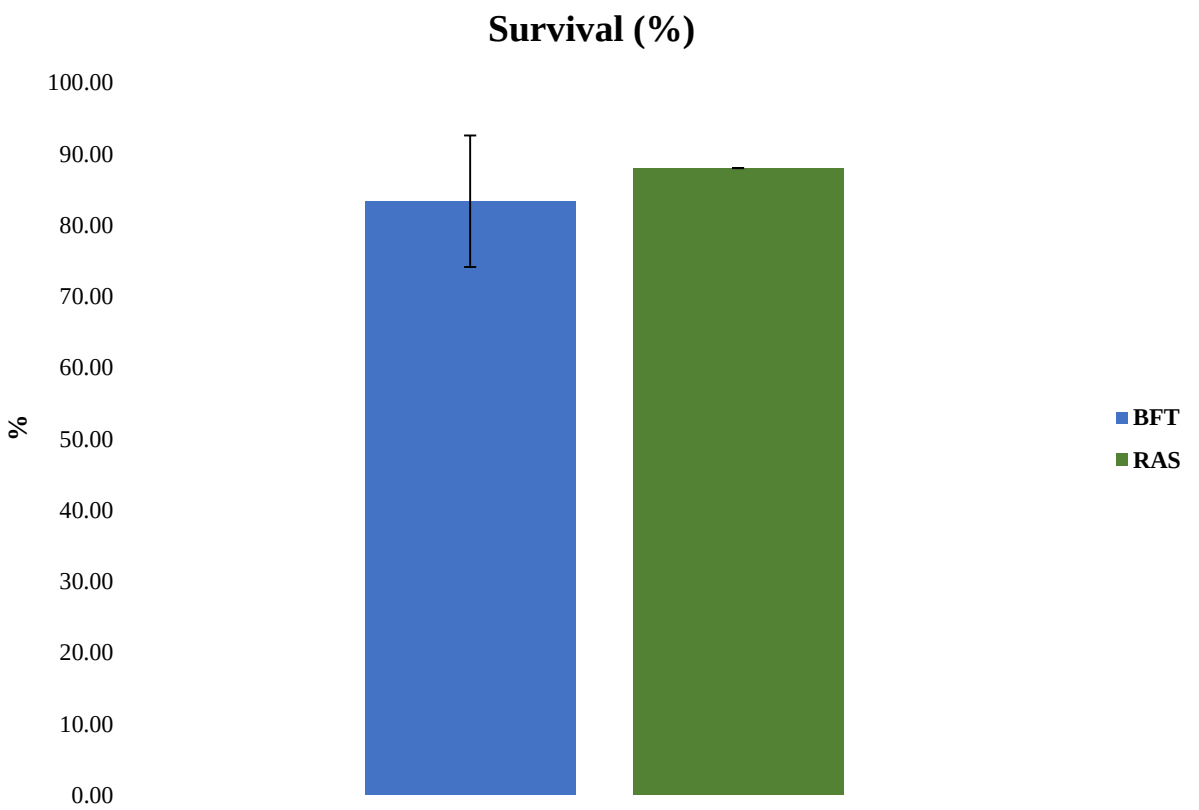


Shrimp growth






Yield (Kg m-3)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Kg m-3
BFT
RAS


Survival (%)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
%
BFT
RAS


1624.23 g


AQUATIC
ECO-SYSTEMS, INC.
Aquatic Eco-Systems, Inc.
1767 Benbow Court
Apopka, Florida 32703
E-Mail: aes@aquaticeco.com

RAS **Biofloc**

Conclusion

- Complete maturation of the system was not observed in the BFT treatment throughout the experimental time;
- The control of nitrogenous compounds was better in the RAS treatment;
- Shrimp growth was better in the BFT treatment than in the RAS treatment;
- Higher yield of the BFT treatment, when compared to RAS.

Perspectives

- The state of Virginia has great potential to produce shrimp in biosecure systems, such as RAS and BFT.
- Studies can be carried out seeking to enable the marine shrimp culture using low salinity water, increasing opportunities to bring marine shrimp farming to inland regions.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Thank you!