THE USE OF DIFFERENT QUANTITIES OF ARTIFICIAL SUBSTRATES AND ITS ROLE IN NITRITE METABOLISM IN THE *Litopenaeus vannamei* BIOFLOC CULTURE SYSTEM

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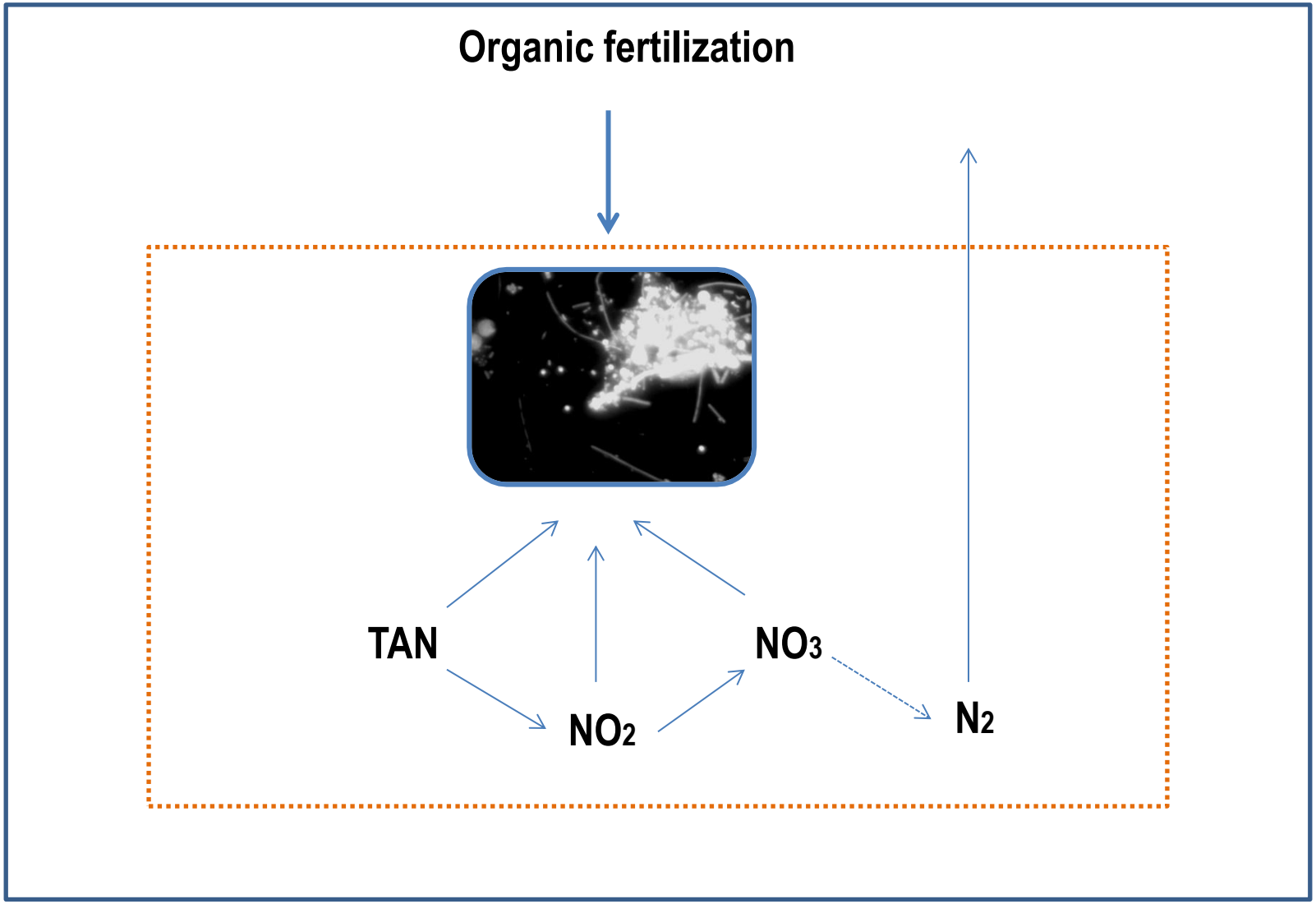
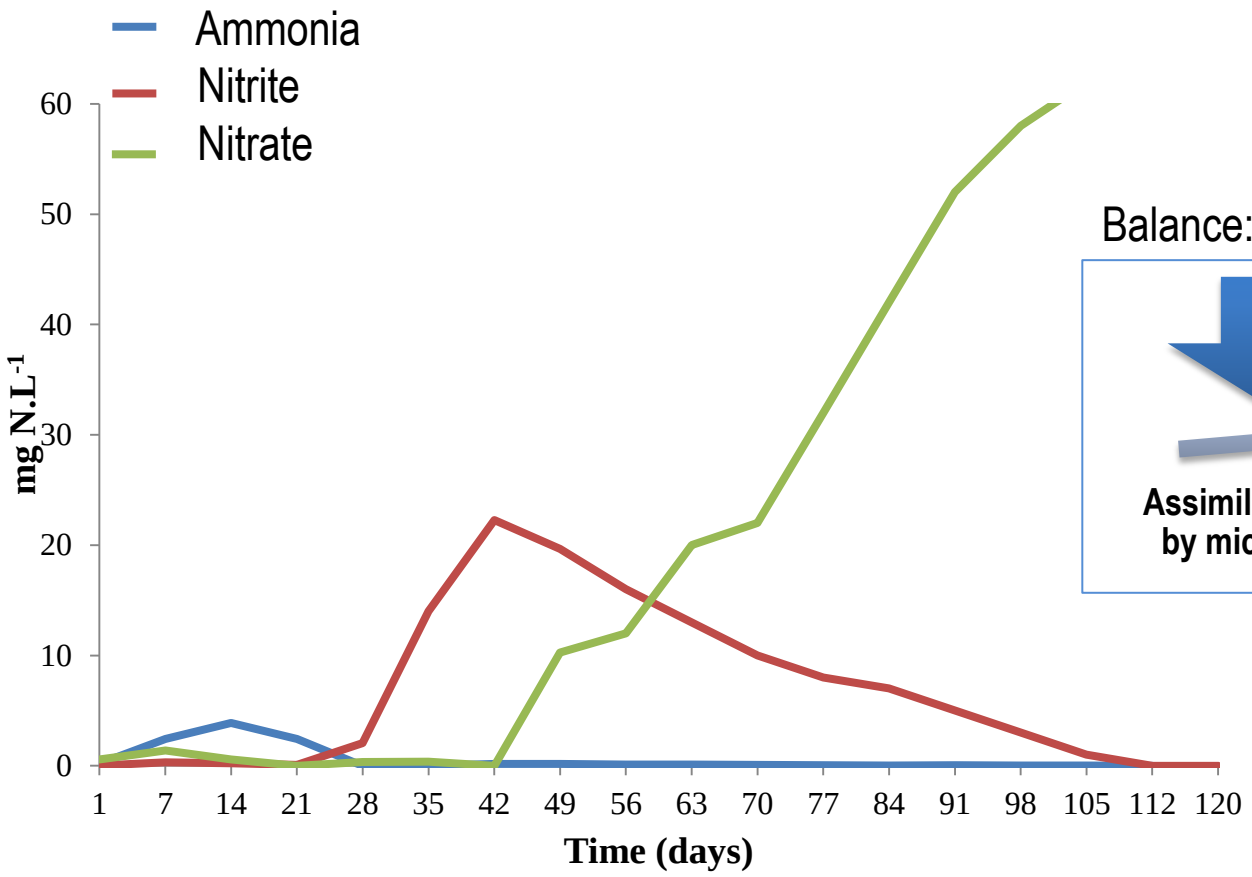
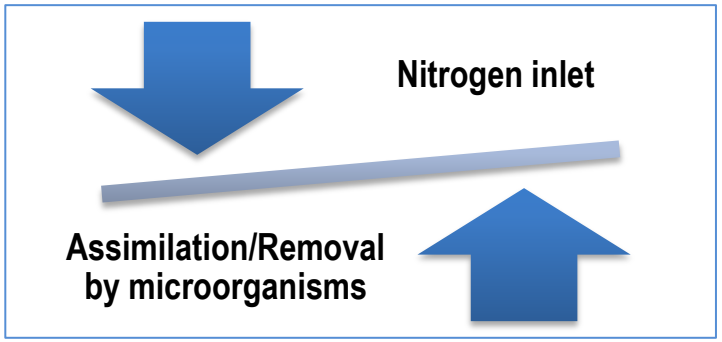
NITROGEN COMPOUNDS IN BIOFLOC TECHNOLOGY SYSTEM



Cycling Processes of Nitrogen Assimilation/Removal in BFT System





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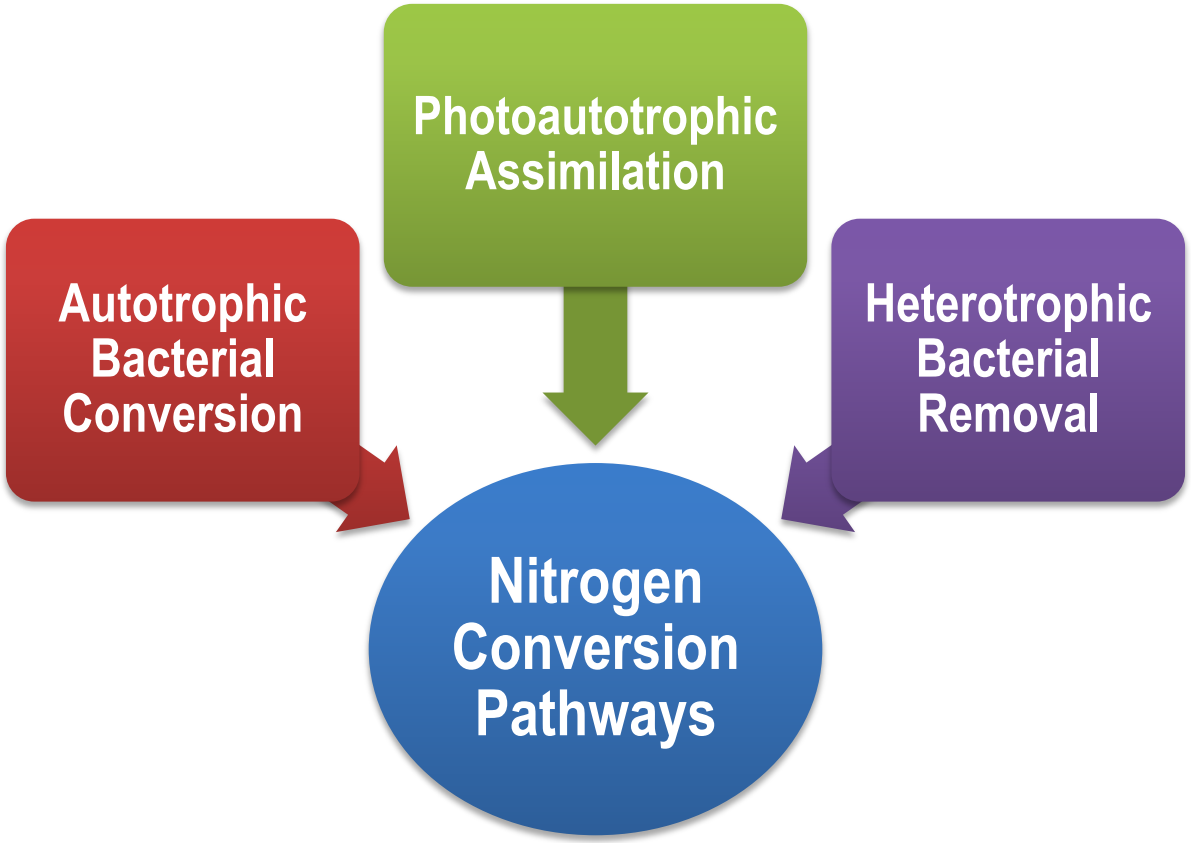


Biofloc strategies for super-intensive shrimp production typically include members of all three of these microbial communities (Otoshi et al. 2010)

How nitrite buildup occurs in BFT system?

High stocking densities → feed rates + excretion rates + improper growth of bacterial groups = faster and higher spikes of ammonia and/or nitrite

AUTOTROPHIC X HETEROTROPHIC

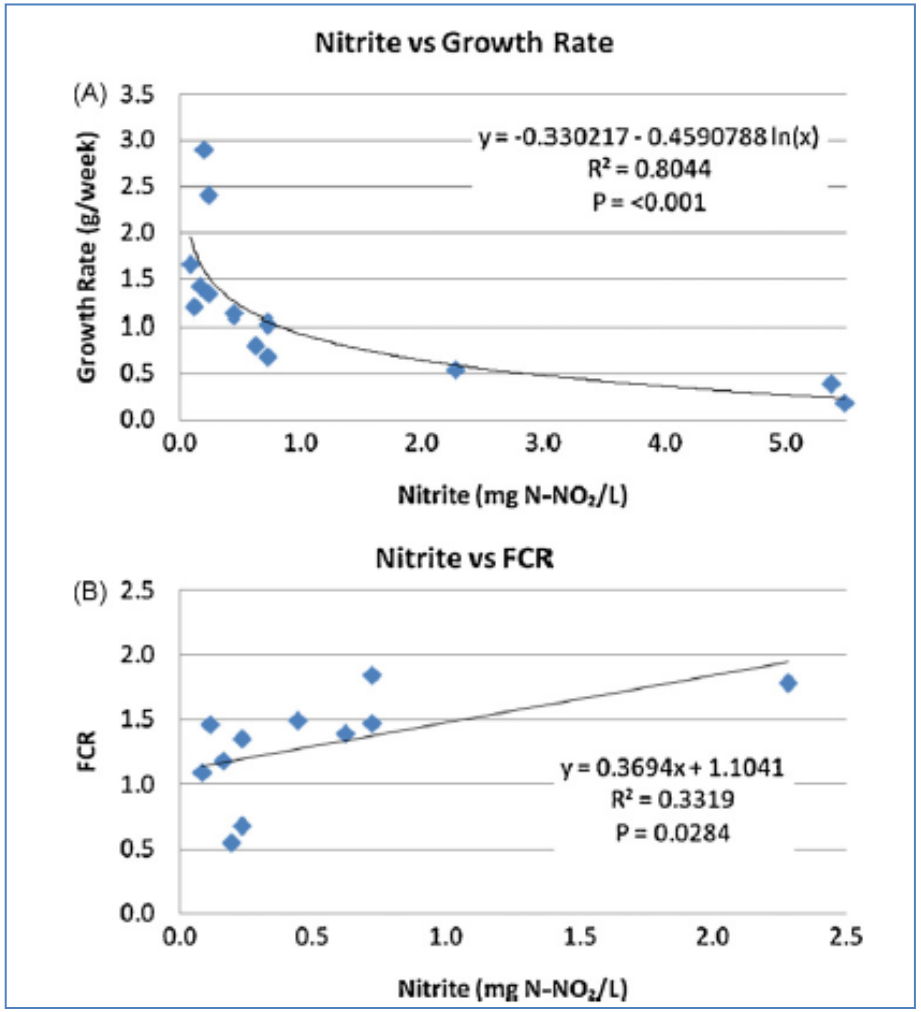
More efficient in TAN removing
Slow growth rate (AOB > NOB)

Growth rate ~ 10x than that nitrifying bacteria
Total suspended solids accumulation

Formation of nitrite >>> Bacterial biomass growth = N-NO_2 buildup

How nitrite buildup affects the culture?

- ❖ Shrimp growth and survival;
- ❖ FCR;
- ❖ Immune ability;
- ❖ Oxygen consumption;
- ❖ Nitrogenous excretion.



Vinatea et al. (2010)

The use of biofilm in BFT systems

- Bacterial removal/assimilation of ammonia and nitrite
- Providing greater surface area for attachment of bacteria

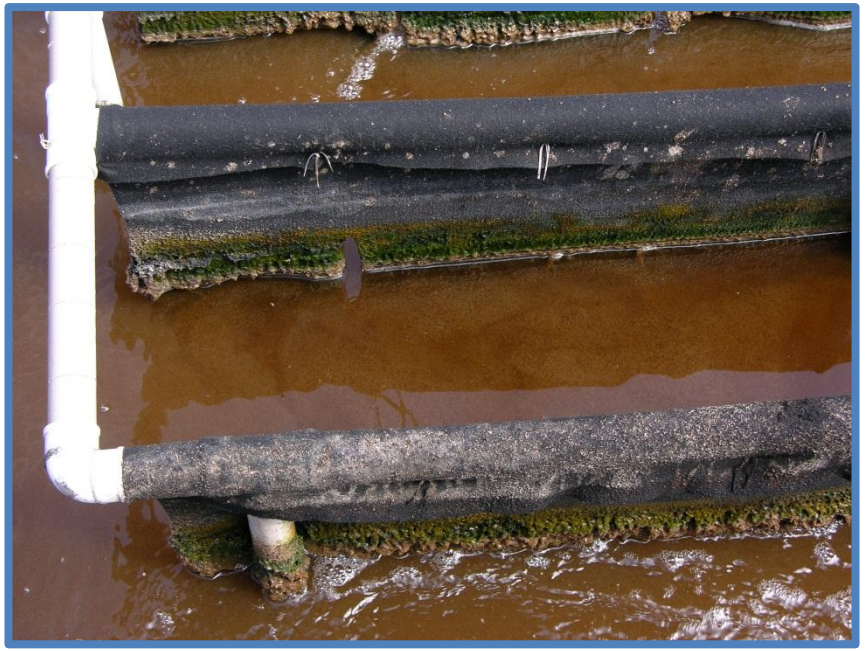
- Greater performance of shrimp → growth and survival; supplemental food; prevention against pathogens.

Which is the amount of artificial substrates necessary to improve the nitrogen cycling?

Objectives:

- Analyze the influence of the biofilm on the nitrite metabolism in a *Litopenaeus vannamei* BFT culture system;

- Evaluate if the amount of artificial substrate added (200 or 400% of lateral area) can contribute in preventing the nitrite buildup in BFT culture system.



Location:

- ❖ Marine Station of Aquaculture
- ❖ Institute of Oceanography, Federal University of Rio Grande, RS, Brazil

Materials and Methods:

- Greenhouse (100 m²)
- 9 rectangular tanks (800L)
- Stocking density: 300 shrimp/m² ~ 500 shrimp/m³;
- Initial weight: 1.27g (± 0.48)
- Duration: 60 days

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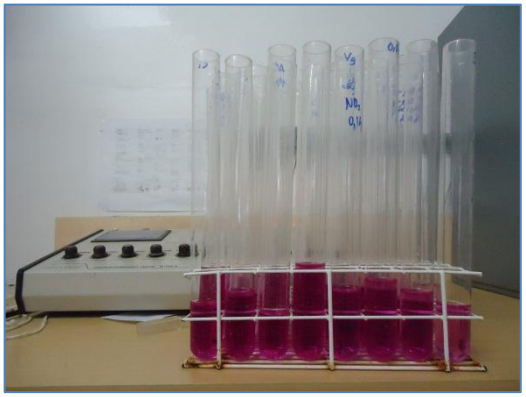
Materials and Methods:

3 treatments (3 replicates each):

- **Control**: in BFT system but with no additional surface area to bacteria attachment;
- **T200**: in BFT system with addition of artificial substrate, increasing the total lateral surface area in 200%;
- **T400**: in BFT system with addition of artificial substrate, increasing the total lateral surface area in 400%.



Results and Discussion:

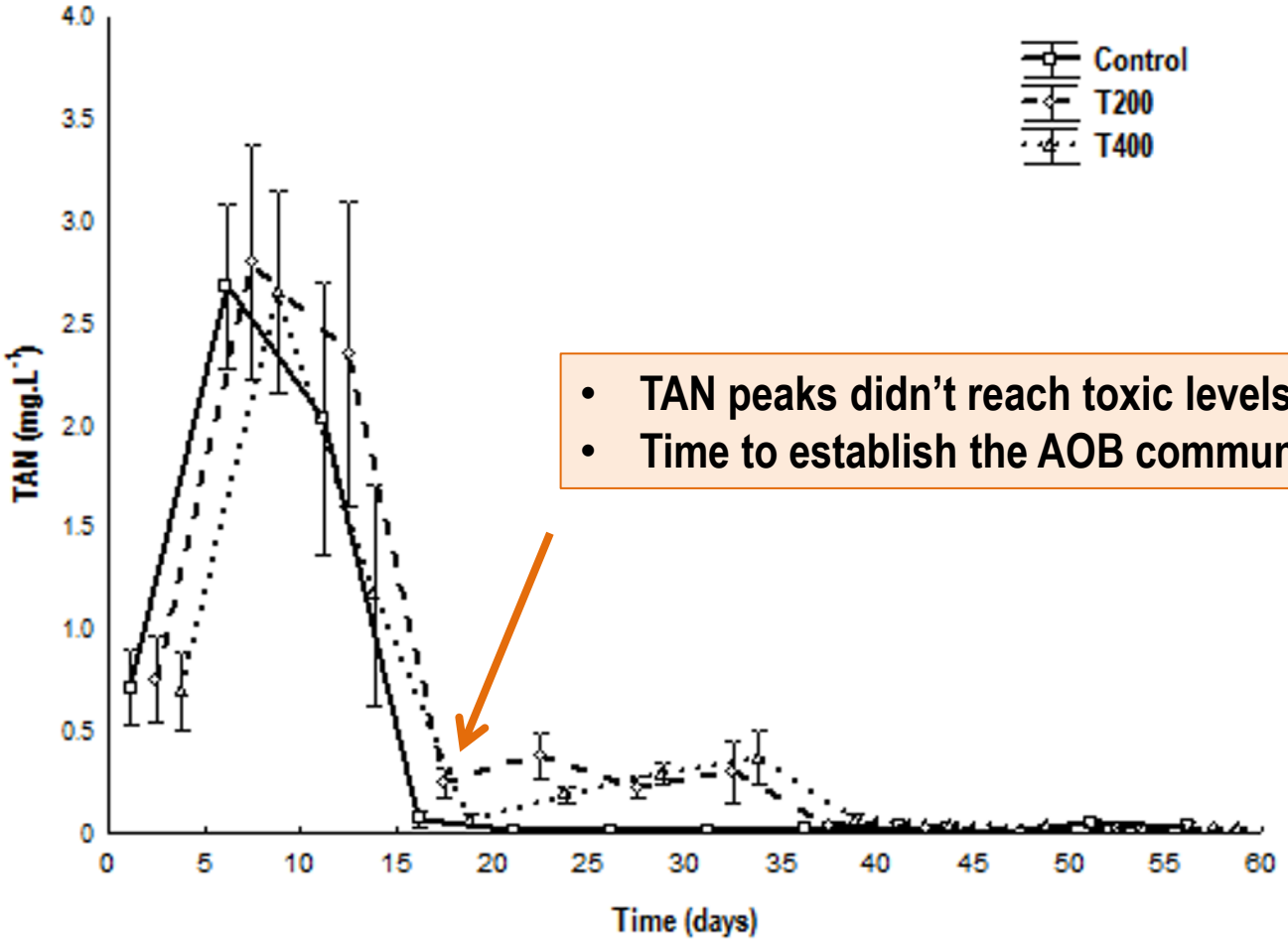
Water Quality:

Treatment	Control	T200	T400
T (°C)	27.25^{a} (± 1.97)	28.15^{a} (± 2.05)	27.62^{a} (± 1.80)
D.O. (mg.L^{-1})	6.07^{a} (± 0.58)	5.90^{a} (± 0.51)	5.98^{a} (± 0.50)
pH	7.80^{a} (± 0.24)	7.86^{a} (± 0.19)	7.92^{a} (± 0.13)
Salinity	23.88^{a} (± 2.01)	24.93^{a} (± 2.09)	24.98^{a} (± 1.96)
SST (mg.L^{-1})	473.48^{a} (±252.39)	321.67^{a} (±261.71)	134.44^{b} (±93.49)
Turbidez (NTU)	191.85^{a} (±128.73)	116.54^{a} (±108.81)	24.98^{b} (±27.05)

❖ Within the recomended levels for *L. vannamei.*

Results and Discussion:

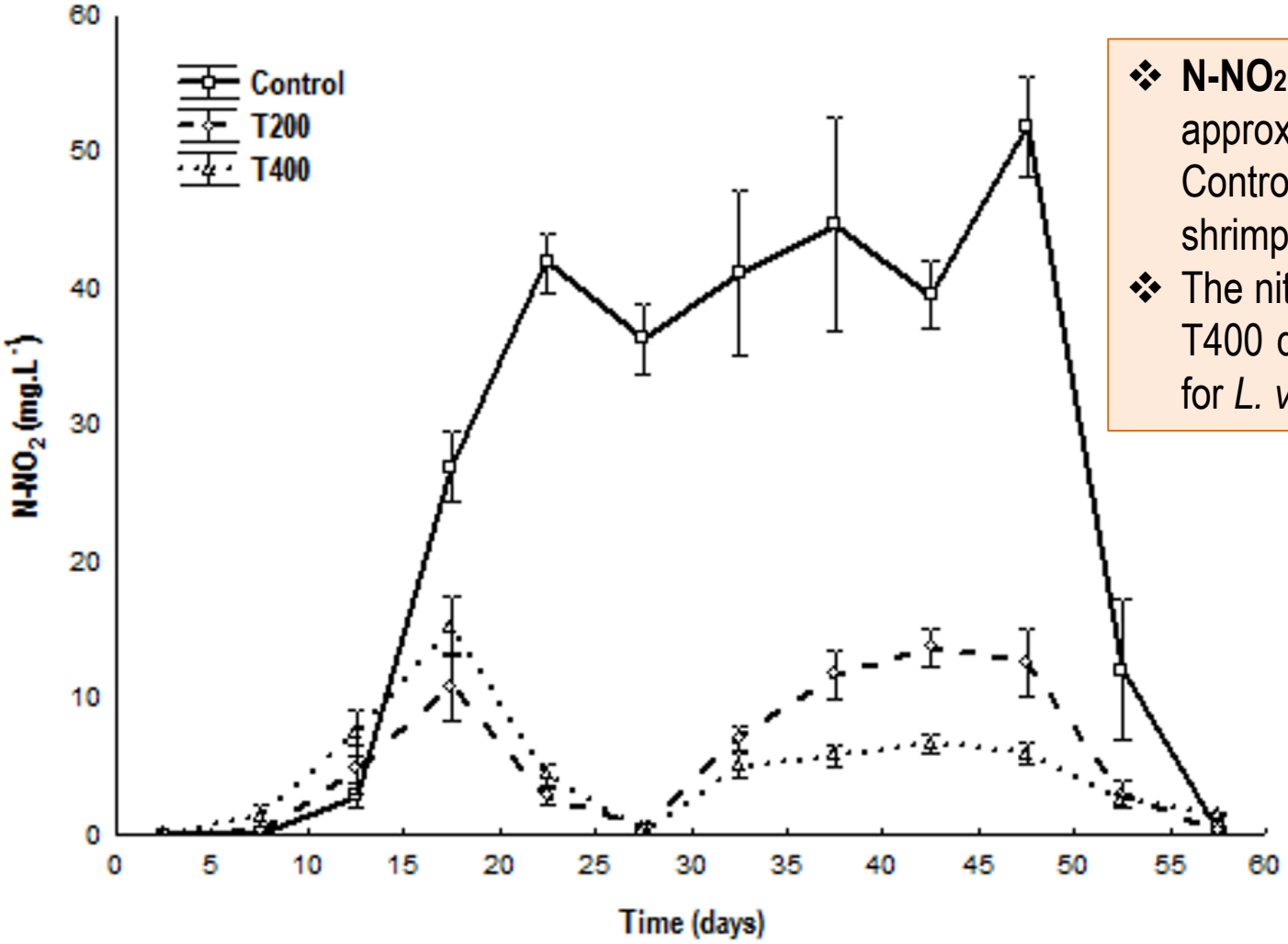
Water Quality – Total Ammonia Concentrations:



- TAN peaks didn't reach toxic levels to shrimp;
- Time to establish the AOB community: about 15 days.

Results and Discussion:

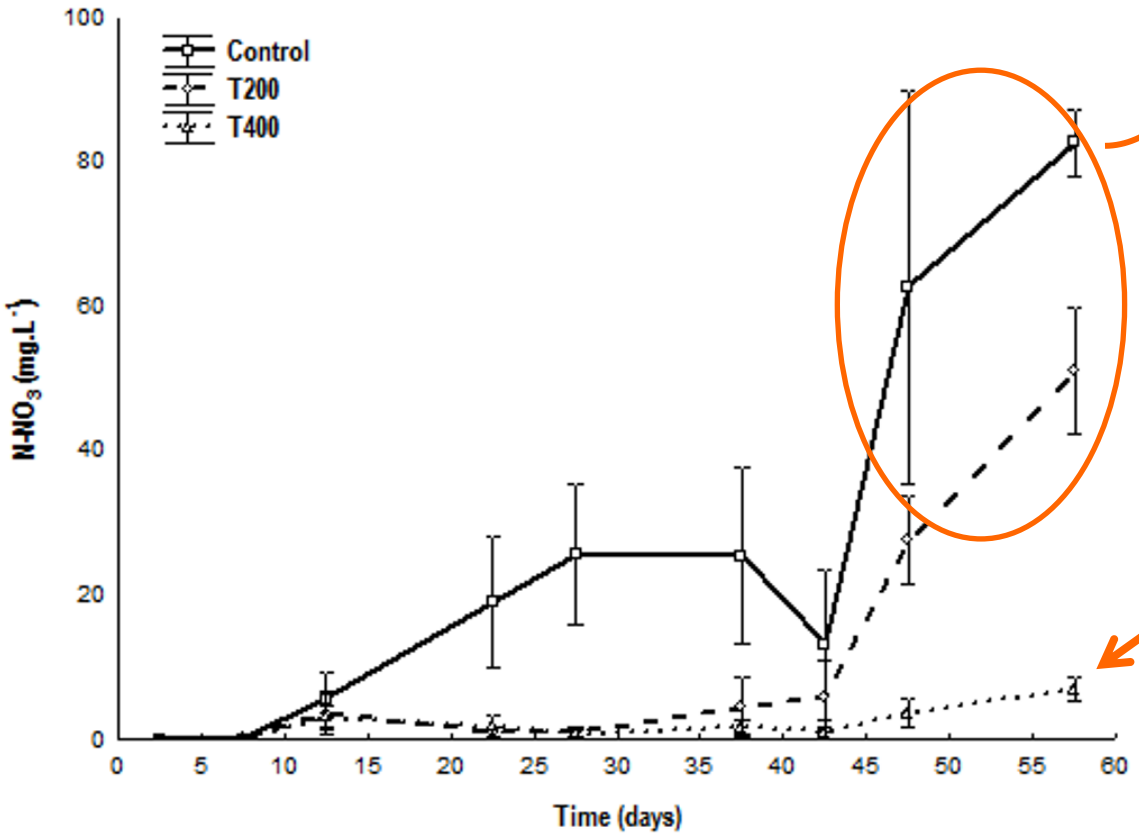
Water Quality – Nitrite Concentrations:



- **N-NO_2 > 25 mg/L** during approximately 35 days in Control – affected survival of shrimp;
- The nitrite spikes in T200 and T400 didn't reach toxic levels for *L. vannamei.*

Results and Discussion:

Water Quality – Nitrate Concentrations:



Control and T200 → autotrophic conversion (increase in nitrate concentrations after 40 days)

Control and T200 → time to establish the NOB community >>> AOB community

T400 → predominance of heterotrophic bacterial removal or photoautotrophic removal during the culture

Results and Discussion:

Water Quality – Nitrogen compounds (means):

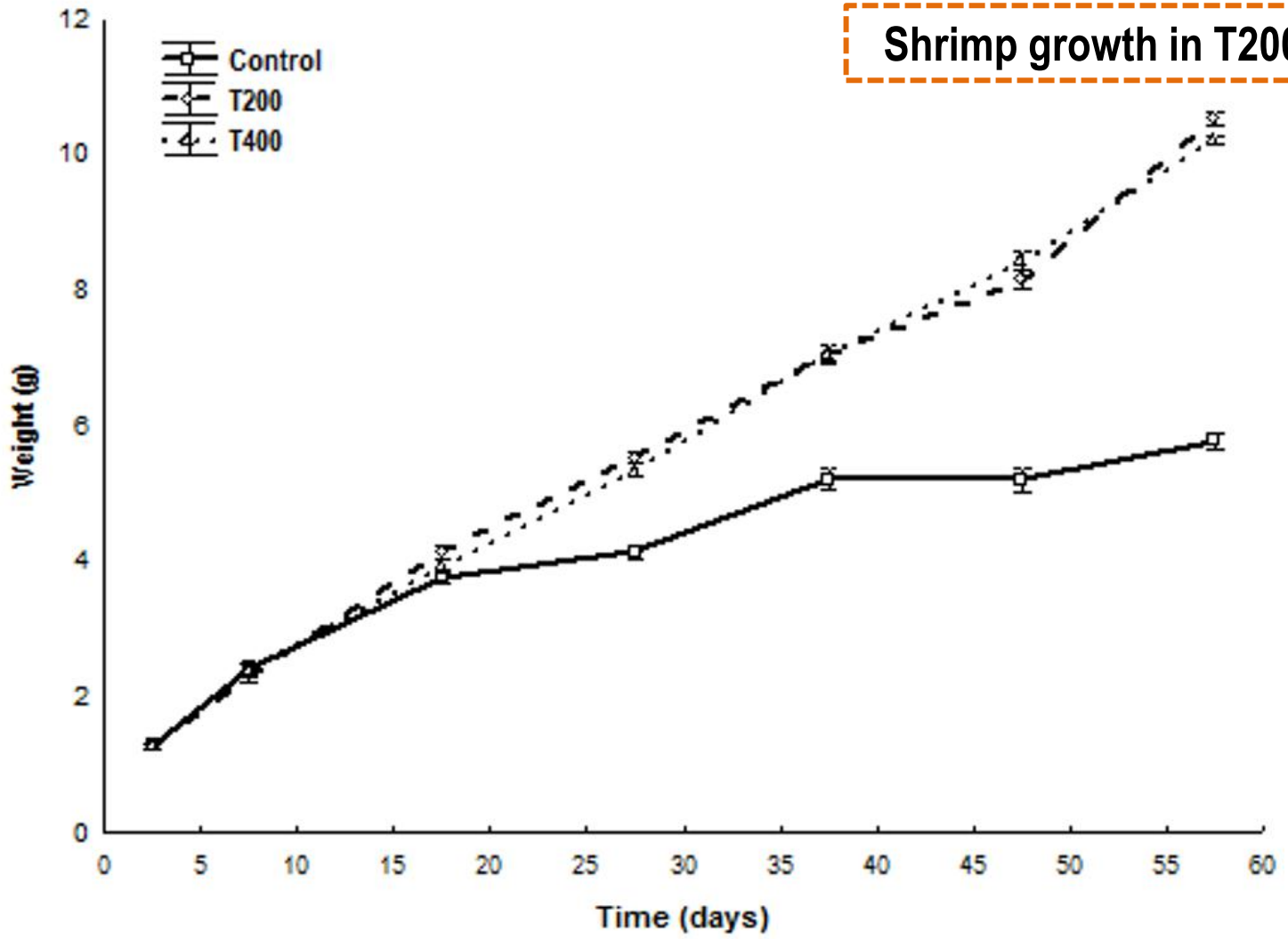
Treatment	Control	T200	T400
N-AT ($mg.L^{-1}$)	0.64^{a} (±1.46)	0.72^{a} (± 1.59)	0.55^{a} (± 1.27)
$N\text{-}NO_2$ ($mg.L^{-1}$)	23.73^{a} (± 23.59)	5.47^{b} (± 7.87)	4.59^{b} (± 5.57)
$N\text{-}NO_3$ ($mg.L^{-1}$)	27.22^{a} (± 32.05)	14.55^{a} (± 22.68)	2.55^{b} (± 3.47)

- Importance of biofilm microbial community in reducing the nitrite concentrations (Thompson et al. 2002; Arnold et al. 2009; Viau et al. 2012)
- Autotrophic bacterial conversion in Control and T200 → higher nitrate concentrations;
- Heterotrophic and photoautotrophic removal in T400 → low total nitrogen concentrations.

Results and Discussion:

Growth Parameters:

Shrimp growth in T200 and T400



Results and Discussion:

Growth Parameters:

Losses in productivity and high FCR due to high nitrite concentrations.

Treatment	Control	T200	T400
Initial weight (g)	1.27 (±0.48)	1.27 (±0.48)	1.27 (±0.48)
Final weight (g)	5.78^{a} (±1.74)	10.53^{b} (±1.67)	10.21^{b} (±1.37)
Survival (%)	42.00^{a} (±6.36)	91.03^{b} (±3.61)	97.30^{b} (±3.11)
Weekly growth rate ($g.week^{-1}$)	0.52^{a} (±0.37)	1.08^{b} (±0.35)	1.04^{b} (±0.17)
FCR	3.22^{a} (±0.33)	1.05^{b} (±0.07)	1.02^{b} (±0.05)
Productivity ($kg.m^{-2}$)	0.71^{a}(±0.09)	2.87^{b} (±0.14)	2.98^{b} (±0.15)
Productivity ($kg.m^{-3}$)	1.24^{a} (±0.15)	5.03^{b} (±0.25)	5.22^{b} (±0.26)

Results and Discussion:

Growth Parameters:

Better results in survival, weight gain, FCR and productivity, confirming the importance of biofilm to maintain good water quality and nutrition of shrimps.

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Conclusions:

The use of artificial substrates to promote the biofilm formation can be a strategy to prevent the nitrite spikes in *L. vannamei* BFT culture system?

<u>Yes, this study confirm the role of artificial substrates in maintain the nitrite concentrations above the toxic levels for L. vannamei.</u>

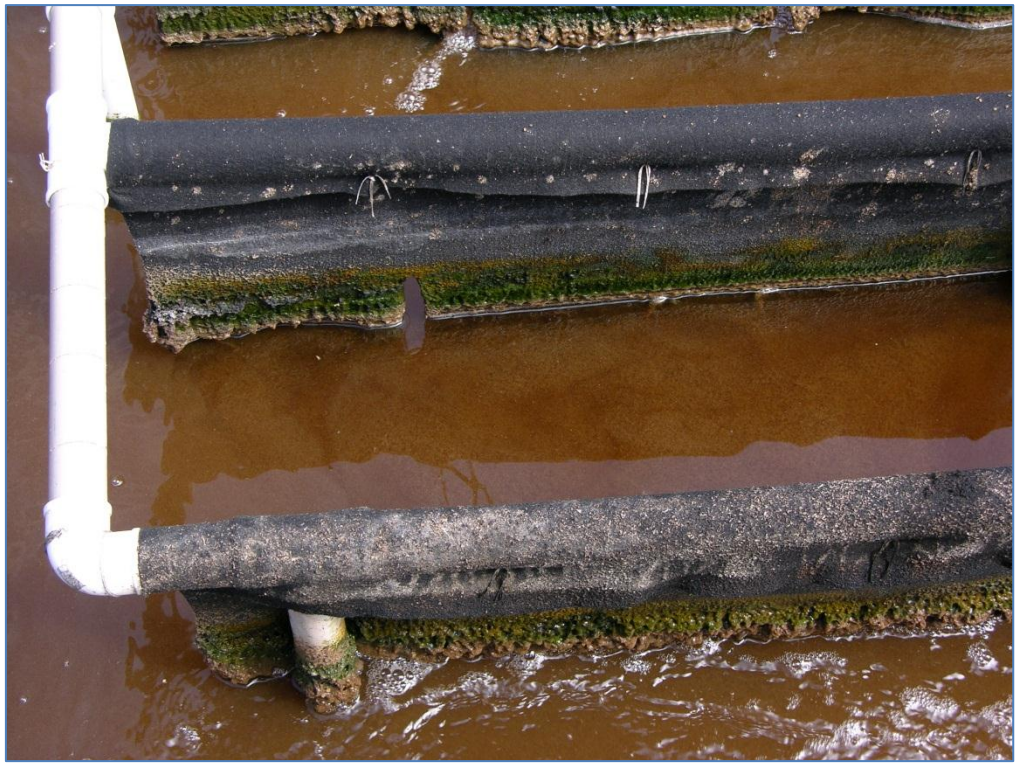
Conclusions:

The use of artificial substrates to promote the biofilm formation may improve the growth parameters in biofloc system?

Yes, our results show that the biofilm is an important additional food source for shrimp, improving the growth performance in BFT system.

Conclusions:

The increase from 200 to 400% in lateral area of tanks may influence the nitrogen dynamics in BFT system?



Yes, the quantity of substrates has influenced the nitrogen conversion pathways, showing that the more substrate is added, there is an increase in N removal from water and concomitantly incorporation in shrimp biomass. However, for the quantities tested, no differences were observed in shrimp growth parameters.