Nursery performance of the Pacific White Shrimp *Litopenaeus vannamei* fed two dietary regimes in a zero-exchange, biofloc system

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Introduction

- Postlarvae nutrition, DO levels, and water mixing are factors affecting shrimp performance in intensive zero-exchange biofloc-dominated systems.
- Feeding young PL properly formulated high-quality liquid or dry feeds can be more convenient and cost-effective than live *Artemia*-based diets.
- Maintaining adequate DO levels is crucial for optimizing shrimp performance.
- Water mixing is equally important for even feed distribution and preventing formation of anoxic bottom patches especially during the early nursery phase.

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Objectives

- Evaluate the effect of feeding two dietary regimes on *Litopenaeus vannamei* postlarvae performance in a biofloc-dominated nursery system operated with no water exchange,
- Study the changes in selected water quality indicators throughout the nursery trial, and
- To monitor changes in *Vibrio* populations during the study

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Materials & Methods

System Description

- Six shallow (0.45 m) 40 m^3 RWs EPDM-lined (*Firestone Specialty Products, Indianapolis, IN*)
- Water Mixing, Flow & Oxygenation:
  - Eighteen 2” Air-lift pumps
  - Six 0.9-m air-diffusers
  - One Venturi injector operated with ambient air/O_2
  - Center partition and 2” bottom pipe with spray nozzles
- Particulate Matter Control:
  - Foam Fractionator & Settling Tank
  - Cyclone Filter
- Water Recirculation
  - One 2 HP pump

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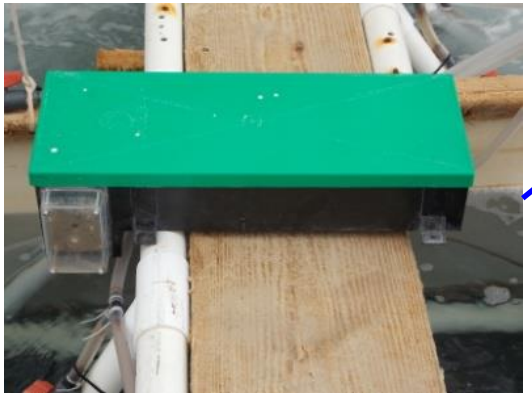
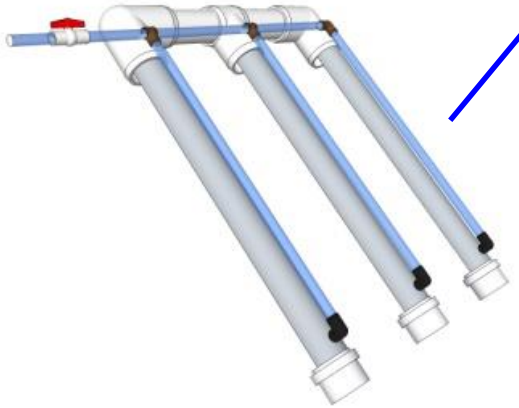
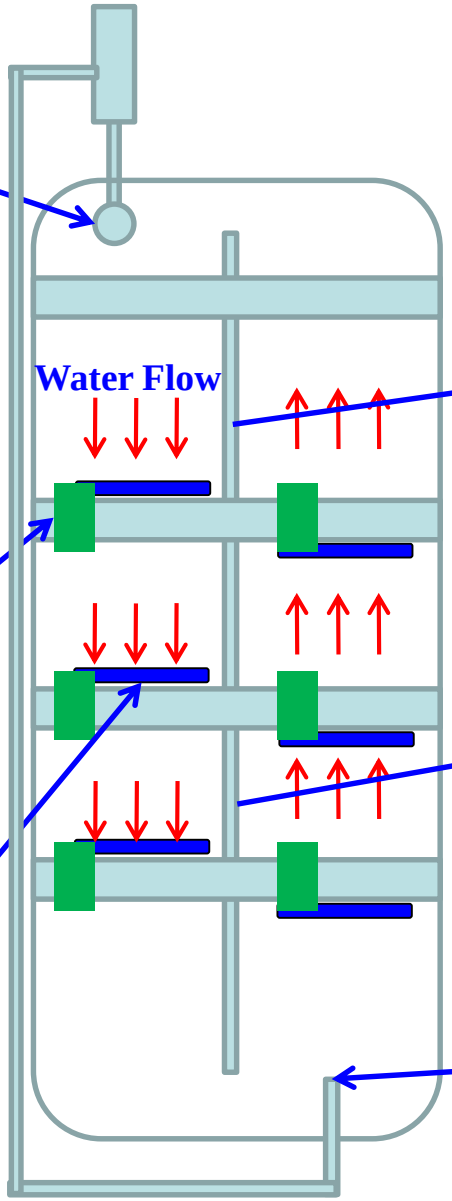
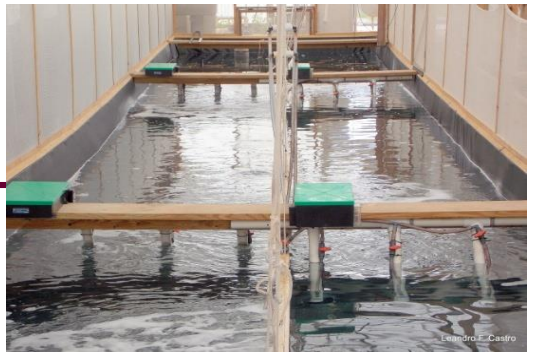
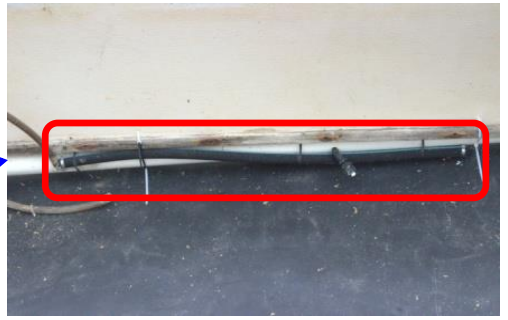
Materials & Methods











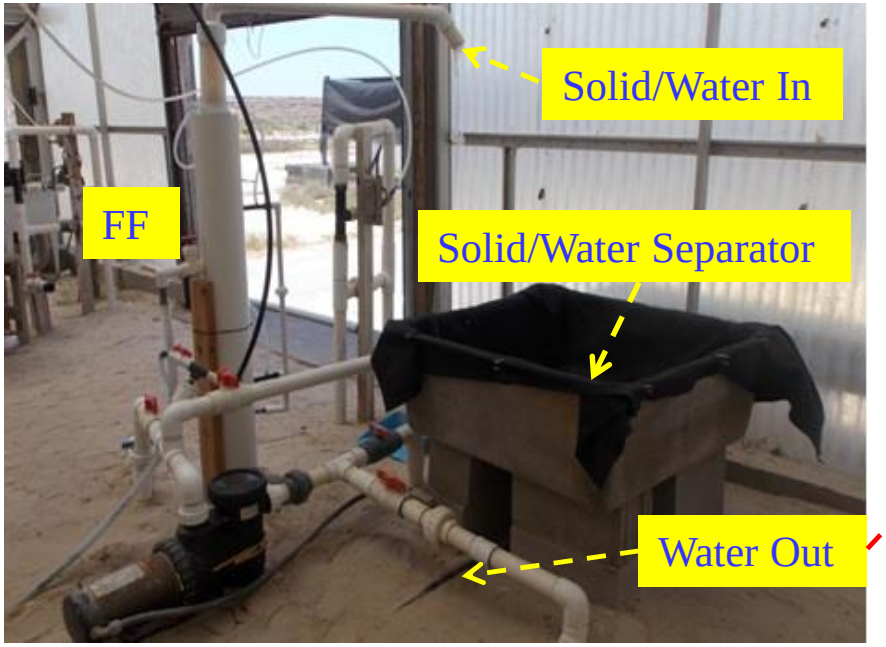
Materials & Methods

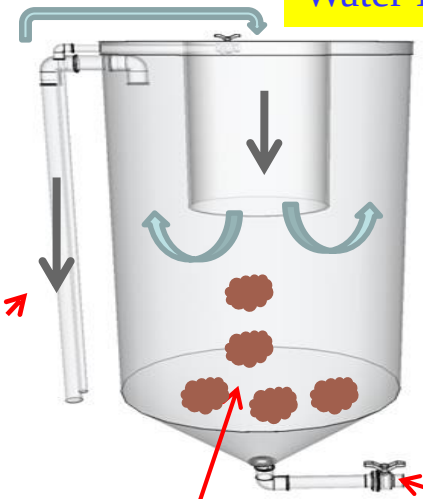
Biofloc & Solids Control & Management (Cyclone Filter, FF & ST):

Solids spun out of suspension

Flow: 50-500 L/min

Min. Pressure: 50 psi





Water In

Solids

Drain Valve

Materials & Methods

- RWs were filled with chlorinated (5 ppm) NSW & 10% aged NSW inoculated with nitrifying bacteria (*KI Nitrifier™ Keeton Industries, Wellington, CO*)
- Salinity was adjusted to and maintained at 30 ppt
- RWs stocked with Fast-Growth/Taura Resistant (*Shrimp Improvement Systems, Islamorada, FL*), $PL_{5\text{-}10}$ (**0.94±0.56 mg; CV: 59.65%!**) at 675/m^3
- Raceways were operated with no water exchange (FW to compensate for losses to evaporation)
- 62 days study duration

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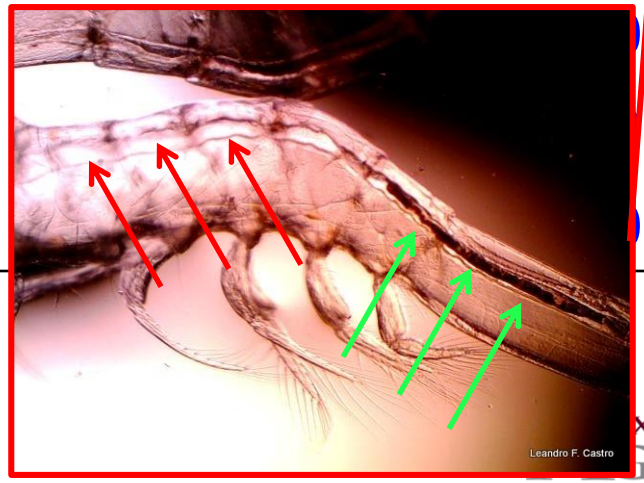
Materials & Methods

- Feed was distributed 24/7 using belt feeders
- Rations during the 1st 8-d were based on feeding table
- From Day 9, in addition to feeding table, rations were established based on 2/wk PL growth sampling, assumed FCR, expected growth, 0.5%/wk mortality, and actual feed consumption

Feed Table for the 1st 8 days

Day	EZ-Art (%)	Dry (%)
1	50 + 50	100
2	50 + 50	100
3	50 + 50	30 + 70
4	40 + 60	30 + 70
5	40 + 60	30 + 70



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Feed*

	Day of Culture		
	0-8	0-27	28-62
Feed Characteristics	EZ - *Artemia* (dry weight)	<400/400-600/ 600-850 µm	1.0/1.5/2.0 mm
Crude Protein (%)	52.0	50.0	40.0
Crude Fat (%)	17.0	15.0	9.0
Crude Fiber (%)	3.7	1.0	3.0
Ash (%)	-	7.5	12.4
Moisture (%)	0.0	10.0	10.0

** Zeigler Bros., Gardners, PA*

Feeds included Vpak®, immune booster & nutritional supplement

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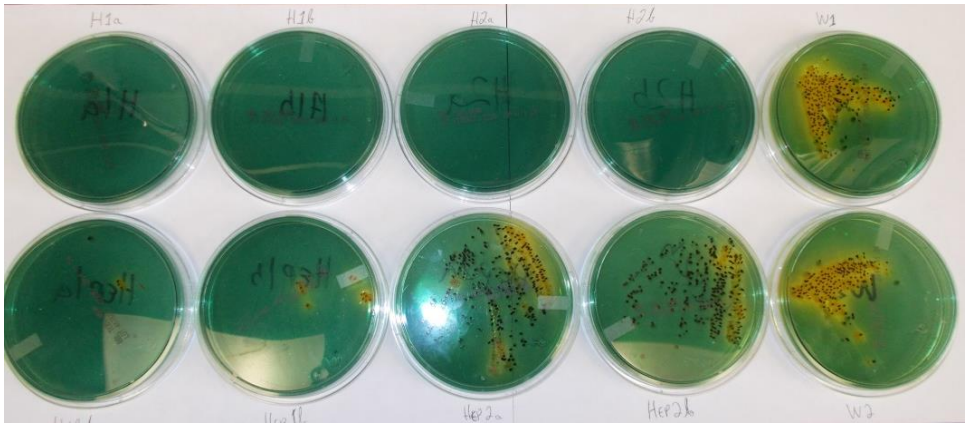
Materials & Methods

- Alkalinity adjusted to 160 mg L^{-1} (as $CaCO_3$) using sodium bicarbonate every 2nd day
- A probiotic was added every 1 to 3 days: Ecopro® (*EcoMicrobials, LLC, Miami, FL*)
- White sugar added as C source (C/N ratio - 6/1)
- *Vibrio* was monitored 2/wk on TCBS
- Targeted TSS and SS levels: 200 to 300 mg L^{-1} and 10 to 14 mL L^{-1}, respectively



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Materials & Methods

Every RW had an optical DO probe and 5500D monitoring system (*YSI Inc., Yellow Springs, OH*)

Monitoring Frequency	Parameters
Twice daily	Temp., Salinity, DO, pH
Daily	SS
Every 2nd day	Alkalinity
Twice weekly	TAN, NO_2-N, TSS
Weekly	NO_3-N, PO_4, Turbidity

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Results

Daily WQ

	EZ-Art		Dry	
	Mean	Min - Max	Mean	Min - Max
Temperature (^{o}C)	26.7	21.6-30.0	26.6	21.6-29.8
DO (mg L^{-1})	6.47	4.60-8.29	6.43	4.60-8.24
pH	8.20	7.79-8.50	8.19	7.80-8.51
Salinity (ppt)	30.3	29.7-31.2	30.3	29.7-31.1

Results

Water Quality

- Ammonia and nitrite levels remained low (< 5.0 and 7.50 mg L^{-1}, respectively) in all six raceways throughout the trial
- SS increased from bdl at stocking to a maximum level of about 30 mL L^{-1} with similar treatment averages (EZ-Art: 13.1 mL L^{-1}, Dry: 11.3 mL L^{-1})
- Although TSS & turbidity levels for the EZ-Art treatment were a little higher than the Dry treatment, these differences were not significantly different

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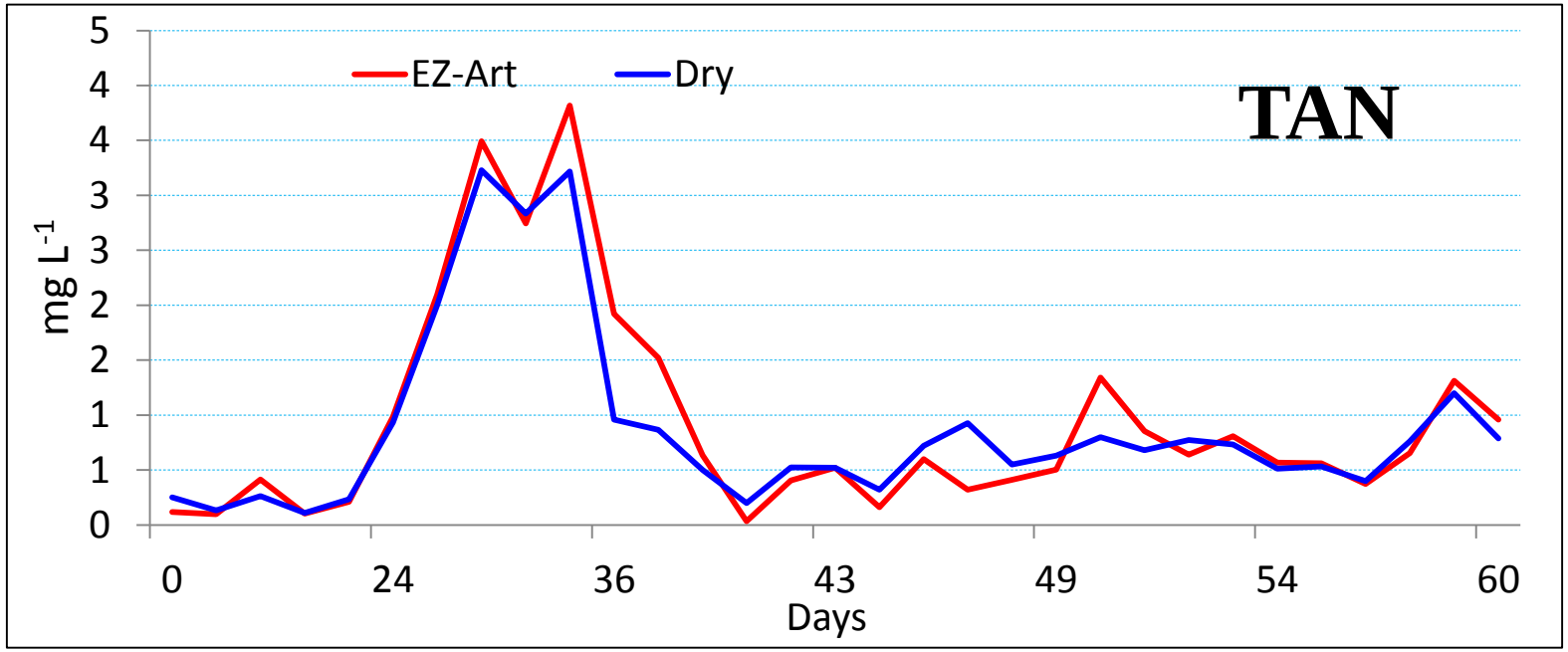
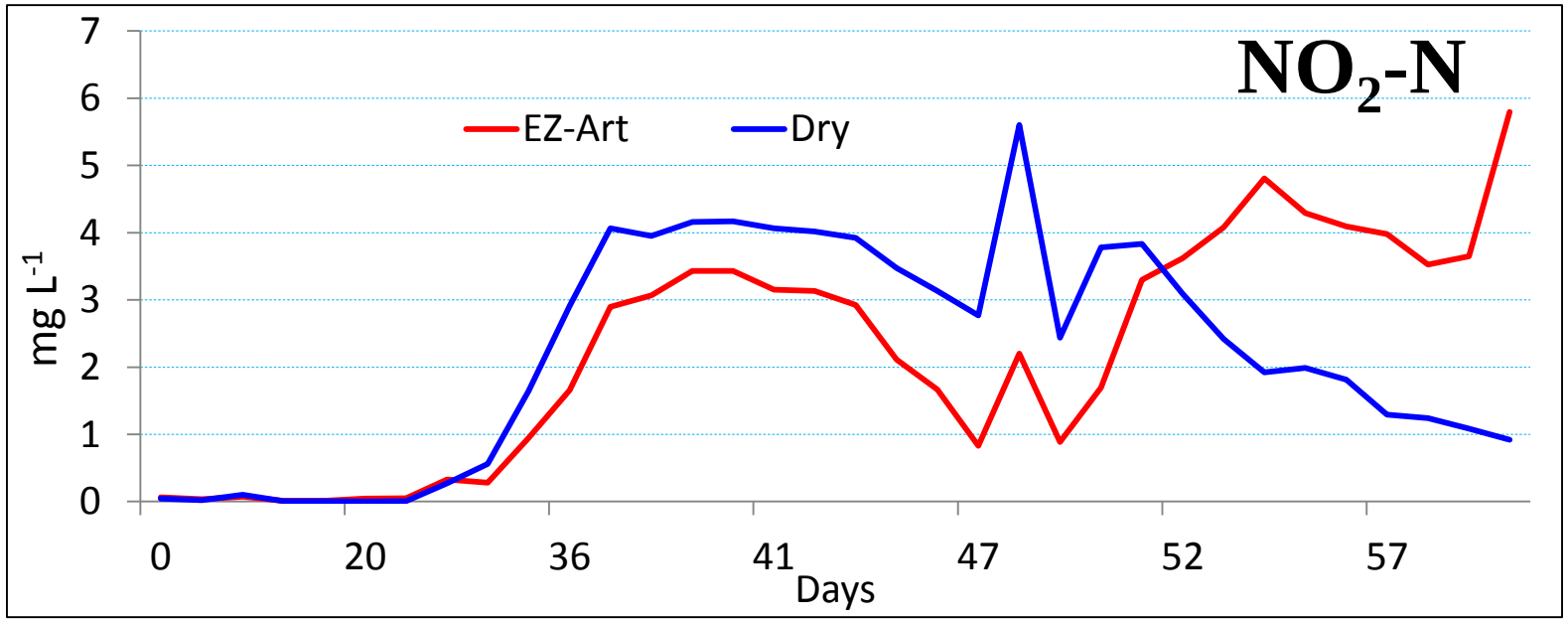

TAN
EZ-Art
Dry
mg L-1
0
1
2
2
3
3
4
4
5
0
24
36
43
49
54
60
Days


NO2-N
EZ-Art
Dry
mg L-1
0
1
2
3
4
5
6
7
0
20
36
41
47
52
57
Days

Summary of alkalinity & particulate matter data

Indicator	EZ-Art		Dry	
	Mean	Min-Max	Mean	Min-Max
ALK (mg L^{-1})	163	144-190	162	144-179
TSS (mg L^{-1})	198	17-663	201	8-638
SS (mL L^{-1})	13	0-31	11	0-30
Turbidity (NTU)	71	1-304	60	1-248

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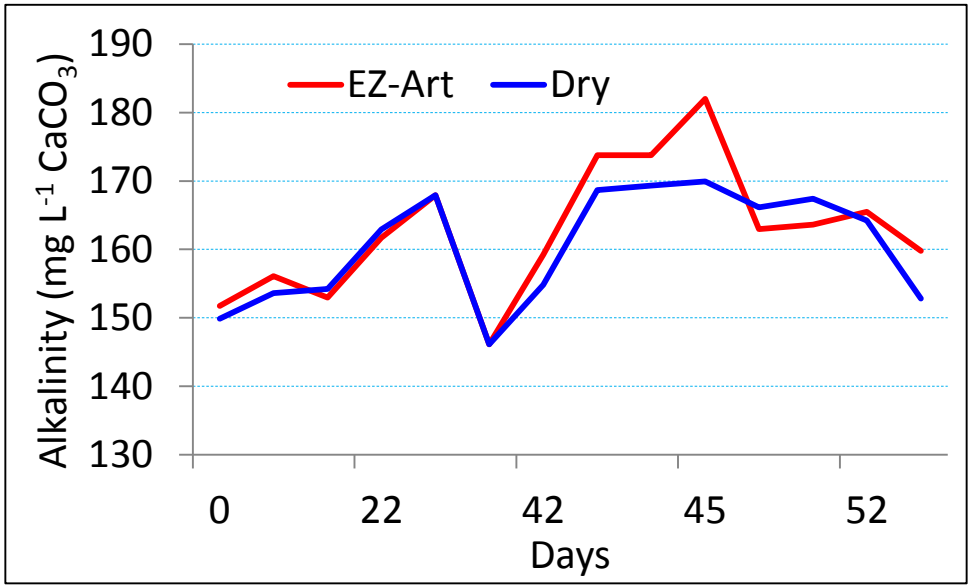
Alkalinity

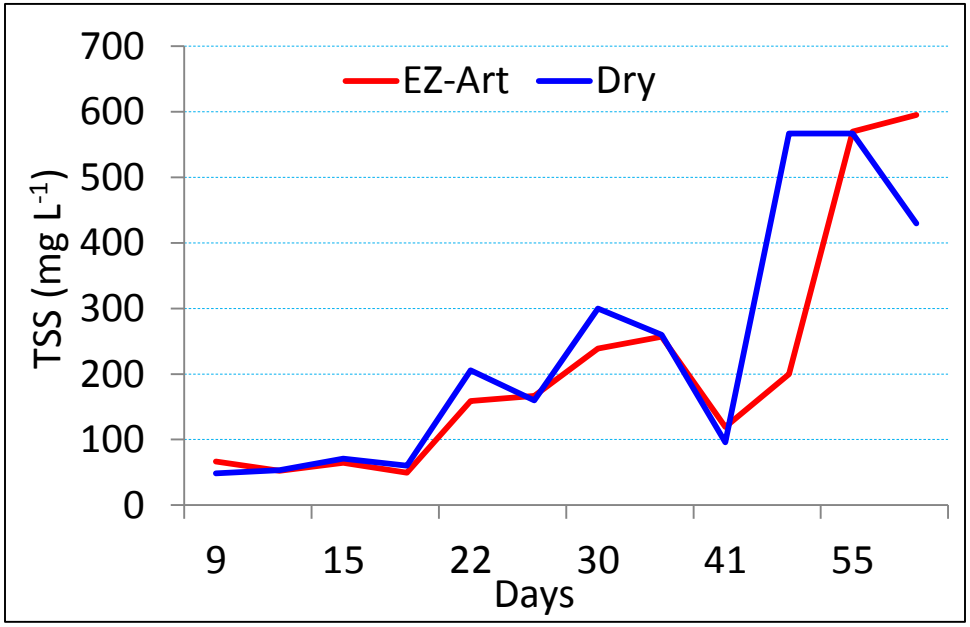


$NaHCO_3$ added/RW:

EZ-Art: 5.73 kg (0.14 kg/m^3)

Dry: 6.12 kg (0.15 kg/m^3)

TSS



Sugar added/RW:

EZ-Art: 32.41 kg (0.81 kg/m^3)

Dry: 27.91 kg (0.70 kg/m^3)

Results

Shrimp Performance

- As stated earlier, the PL high size variation required frequent monitoring of the individual weight to determine the different feed particle sizes needed to accommodate the variable size shrimp
- No significant mortality was observed during the trial
- No statistically significant differences in shrimp performance between treatments

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Shrimp performance in 62-d nursery study

	EZ-Art	Dry
Final Weight (g)	5.50	5.68
Max (g)	12.4	11.8
Min (g)	0.6	0.5
CV (%)	42.2	46.3
Growth (g/wk)	0.60	0.62
Total Biomass (kg)	125.75	128.92
Yield (kg/m^3)	3.12	3.22
FCR	0.91	0.86
Survival (%)	84.80	84.95

Take-home message:

1) Initial size variation is problematic (>> sampling, monitoring, ration calc. etc.)
2) When possible, acquire PL with low size variation

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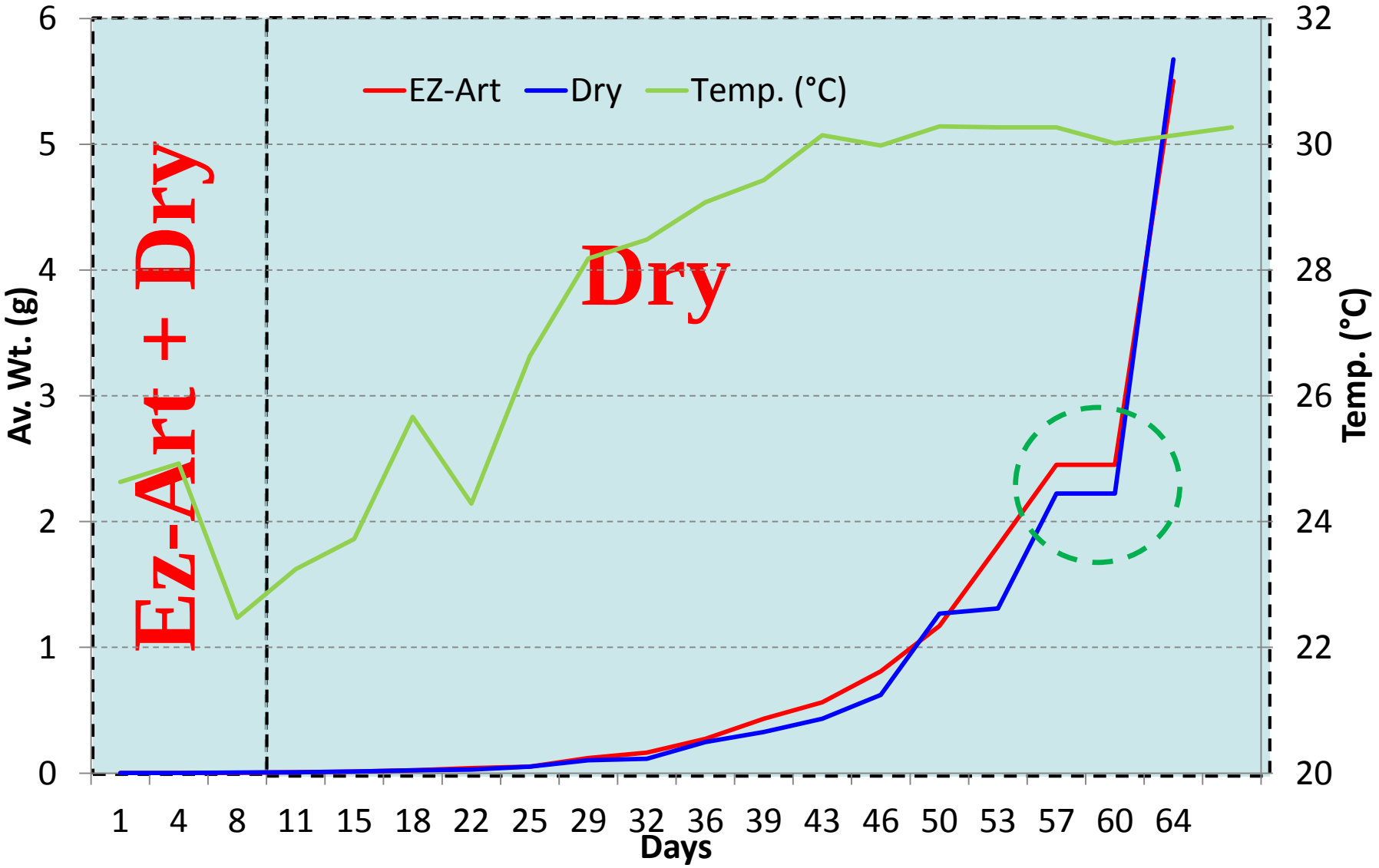
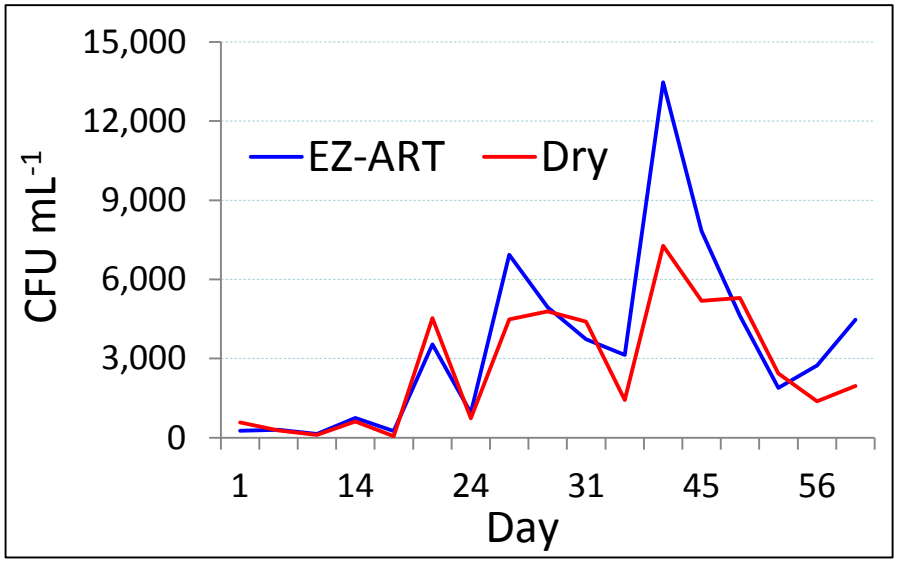
Results

Shrimp Performance

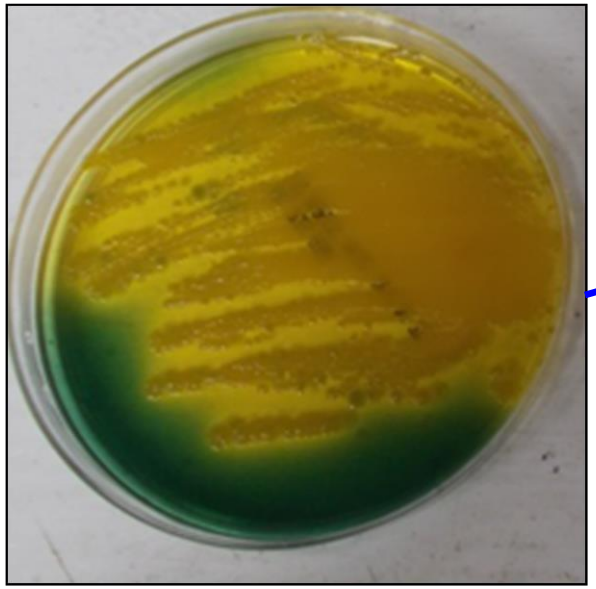


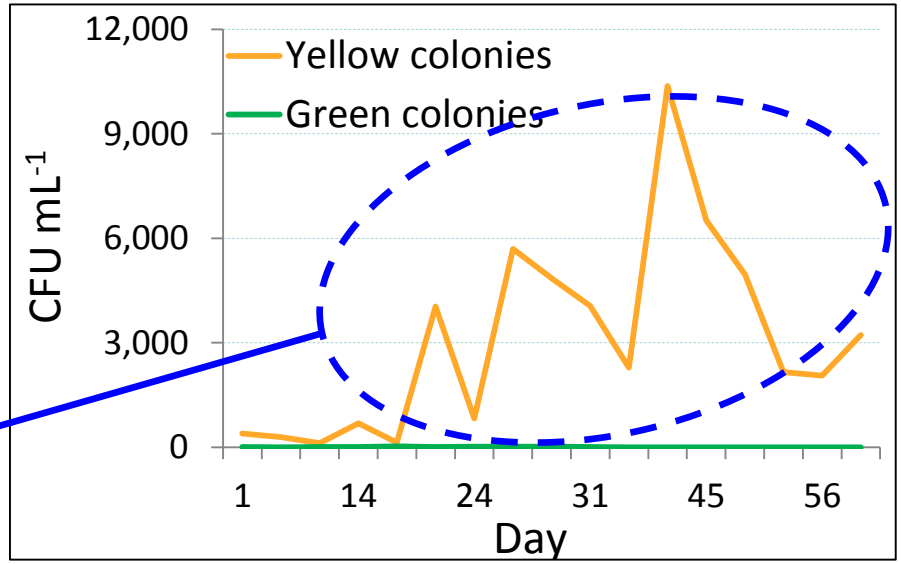
Vibrio colonies in the culture medium

Total



Color





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Conclusion

- Use of nitrifying-rich water prevented shrimp exposure to high levels of ammonia or nitrite.
- Use of a probiotic may have contributed to the low FCR obtained in this study.
- Use of TCBS agar plates to monitor *Vibrio* colonies serves as a good tool for quantifying pathogenic strains.
- Close monitoring of PL feed consumption and matching particle feed size are vital for preventing PL starvation and optimizing nursery performance.
- Use of a micro-capsulated liquid diet & different sizes of crumble feeds together with adequate feed mixing & distribution helped overcome problems associated with high PL size variations.

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Acknowledgements

- *The National Sea Grant, Texas A&M AgriLife Research* for funding
- *Zeigler Bros.* for the feed & funding
- *YSI* for the DO monitoring systems
- *Keeton Industries* for the nitrifying bacteria
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- *Colorite Plastics* for the air diffusers
- *Firestone Specialty Products* for the EPDM liner
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