Comparison of two commercial diets for the production of marketable *Litopenaeus vannamei* in super-intensive, biofloc-dominated, zero-exchange raceways

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USMSFP USDA United States Department of Agriculture National Institute of Food and Agriculture Texas A&M AgriLife Research

Introduction

- Recent advances in super-intensive, limited-discharge, biofloc systems for the culture of *Litopenaeus vannamei*, suggest that these systems can be profitable when used to produce live or fresh (never frozen) shrimp for niche markets
- Researchers, supported in part by the United States Marine Shrimp Farming Program have been working to improve system efficiency and make this technology economically viable

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Introduction

- These systems offer improved biosecurity with reduced risk of crop losses to viral diseases
- Furthermore, operating these systems with no water exchange minimizes the negative effluent impact on receiving waters

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Objectives

- To study the performance of *Litopenaeus vannamei* juveniles fed two commercial diets under high density and no water exchange
- To study the changes in selected WQ indicators in RWs stocked with these shrimp
- To study the benefit of using the YSI 5500 DO monitoring system as a management tool for a super-intensive, zero-exchange shrimp production system

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Materials & Methods

- Six 40 m^3 EPDM-lined RWs (Firestone Specialty Products, Indianapolis, IN) filled with a mixture of seawater (22 m^3), and biofloc-rich water (18 m^3) used in an earlier nursery trial
- Salinity was adjusted to 30 ppt
- RWs were stocked at 500/m^3 with juveniles (2.66 g) from a cross between Taura Resistant and Fast-Growth genetic lines (Shrimp Improvement Systems, Islamorada, FL)

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Materials & Methods

- Each RW had eighteen 5.1 cm airlifts, six 1 m long air diffusers (AeroTube, Colorite Division, Tekni-Plex, Austin, TX) and a center longitudinal partition over a 5.1 cm PVC pipe with spray nozzles fed by a Venturi injector operated by a 2 hp pump
- Raceways were operated with no water exchange
- Evaporation was weekly compensated by adding chlorinated municipal freshwater

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Materials & Methods

- Three RWs were fed HI-35 ($1.75/kg) while three others received SI-35 ($0.99/kg) feed (Zeigler Bros., Gardners, PA)
- Feed was distributed continuously 7 days a week using belt feeders
- Rations were initially determined using an assumed FCR of 1.4, growth of 1.5 g/wk, and mortality of 0.5%/wk, and were adjusted according to twice a week growth samples

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Materials & Methods

- Each RW optical DO monitoring systems (YSI 5500, YSI Inc., Yellow Springs, OH) for continuous DO monitoring
- Water temperature, salinity, DO, and pH were monitored twice daily; ammonia-N, nitrite-N, nitrate-N, alkalinity, settleable solids, turbidity, TSS, VSS, and $cBOD_5$ were monitored once a week
- Alkalinity was adjusted to 150-200 mg/L (as $CaCO_3$) using sodium bicarbonate

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Materials & Methods

- All RWs were outfitted each with a small commercial Foam Fractionator (VL 65 Aquatic Eco Systems, Apopka, FL) and a settling tank
- FFs & ST were used to control particulate matter and dissolved organics, originally targeting TSS and SS levels in the ranges of 200-300 mg/L and 10-14 mL/L, respectively

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Results

- The optical DO monitoring probe (YSI 5500, Yellow Springs Instruments, OH) of the monitoring system worked very well
- The use of this system enabled better scheduling of the feeding and minimized DO fluctuations
- TSS, turbidity and VSS levels remained significantly higher in the SI-35 treatment
- These results may be related to the higher levels of non-digestible components contained in the SI-35 than HI-35
- Fiber: 2.69% vs. 1.61%
- Ash: 11.11% vs. 9.55%

Daily WQ Data

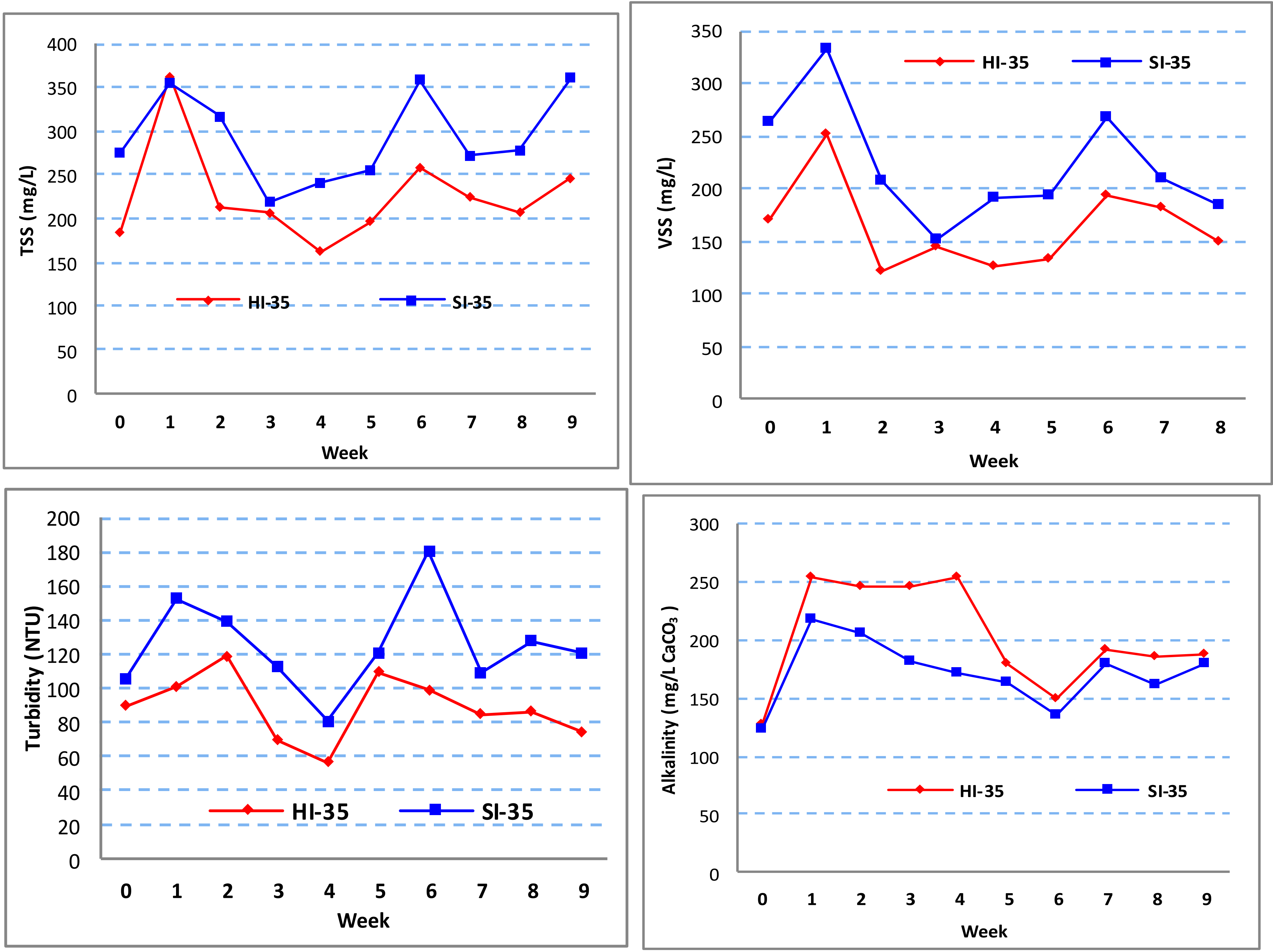
		HI-35		SI-35	
		Mean	Min - Max	Mean	Min - Max
Temperature (C)	a.m.	29.6	27.5-30.7	29.5	28.1-30.5
	p.m.	30.5	28.2-31.6	30.3	28.8-31.5
DO (mg/L)	a.m.	5.9	4.6-7.0	5.9	4.6-7.6
	p.m.	5.5	4.7-6.6	5.5	4.5-7.0
pH	a.m.	7.1	6.6-7.5	7.1	6.7-7.5
	p.m.	7.1	6.2-7.6	7.1	6.3-7.5
Salinity (ppt)		28.3	24.4-36.5	28.3	24.6-36.7

Results

- Ammonia and nitrite levels stayed low (< 0.5 and 1.22 mg/L, respectively) in all six raceways throughout the trial
- Nitrate increased from about 40 mg/L at the study initiation to a maximum of 359 mg/L at the end of the trial

Weekly Solids and Alkalinity Data

	HI-35		SI-35	
	Mean	Min-Max	Mean	Min-Max
ALK (mg/L)	208[a]	123-274	171[b]	102-230
TSS (mg/L)	223[a]	115-552	278[b]	155-460
VSS (mg/L)	161[a]	92-435	205[b]	117-288
SS (mL/L)	8	2-21	11	2.5-27
Turb. (NTU)	90[a]	46-132	125[b]	68-246



TSS (mg/L)
Week
HI-35
SI-35
VSS (mg/L)
Week
HI-35
SI-35
Turbidity (NTU)
Week
HI-35
SI-35
Alkalinity (mg/L $CaCO_3$)
Week
HI-35
SI-35

Results

- Sodium bicarbonate was initially added to RWs equivalent to ~20% of the feed to target 160 mg/L $CaCO_3$
- The HI feed did not reduce the alkalinity at the same rate experienced with the SI-35 feed
- This quickly led to a separation in alkalinity between treatments due to the initial overcompensation in the HI-35 treatment
- By Week 5 the alkalinity levels in the two treatments were similar

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Results

	HI-35	SI-35
	Mean	Mean
Water use (L/kg shrimp)	124.7	138.3
Bicarbonate (kg)	41.6	53.6
Molasses (L)	10	10
Foam fractionator (h)	812	1,253
Settling tank (h)	87	391

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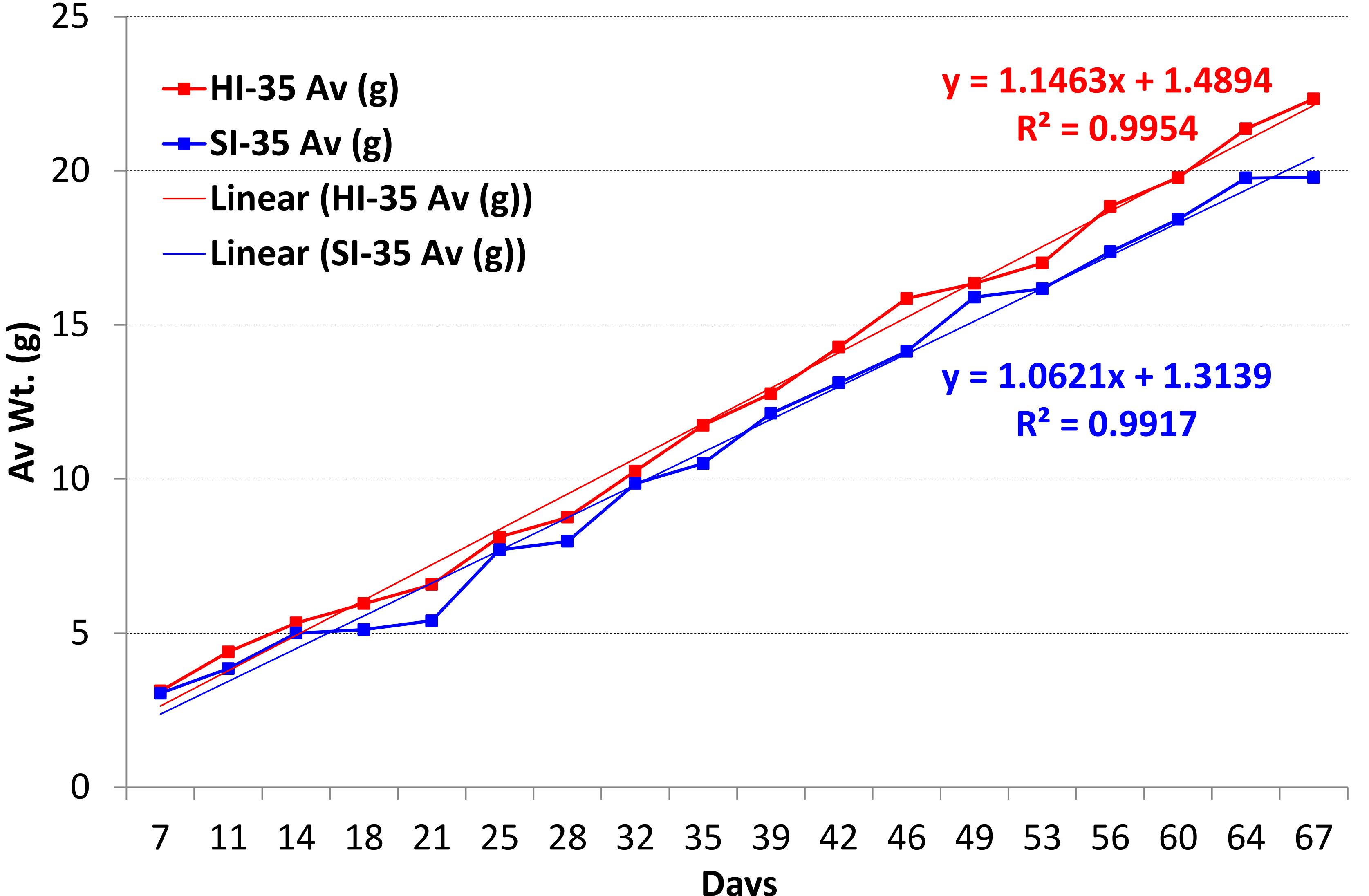
Growth Performance



- P= 0.62

Performance of shrimp fed HI-35 & SI-35 diets in a high-density 67-d in biofloc dominated system

	HI-35	SI-35
Final Weight (g)	22.12 ± 11.35[a]	19.74 ± 8.28[b]
Growth (g/wk)	2.03 ± 0.01[a]	1.76 ± 0.10[b]
Total Biomass (kg)	389.8 ± 1.77[a]	348.5 ± 9.21[b]
Yield (kg/m^3)	9.74 ± 0.04[a]	8.71 ± 0.22[b]
FCR	1.25 ± 0.01[a]	1.43 ± 0.04[b]
Survival (%)	87.4 ± 0.52[a]	88.3 ± 4.18[a]

* Although the cost difference between the HI & SI feeds is significant ($1.75/kg vs. $0.99/kg), a preliminary economic analysis indicates that both feeds would be commercially viable with the profit advantage in favor of the HI feed

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Issues to address

- Operating year round
- Disease
- PL Supply
- Marketing
- Feed cost
- FCR
- Growth
- Survival
- Energy & Temperature control
- Zero exchange vs. Recirculating

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Opportunities for the Future

- Improved technology continues to increase growth and production rates while reducing variable costs
- Continued genetic selection should favor higher yields over time
- Financial analyses are focusing research to sharpen competitiveness
- Marketing opportunities
  - Consistent fresh never frozen product
  - Improved image as a domestic producer of healthy food in eco-friendly systems

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