THE EFFECT OF TWO COMMERCIAL FEEDS AND DIFFERENT C:N RATIOS ON SELECTED WATER QUALITY INDICATORS AND PERFORMANCE OF *Litopenaeus vannamei* JUVENILES CULTURED AT HIGH DENSITY IN A BIOFLOC-DOMINATED ZERO-EXCHANGE OUTDOOR TANK SYSTEM

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Introduction

Operating zero-exchange biofloc-dominated systems can potentially:

- Increase bio-security
- Increase production
- Reduce effluent discharge
- Reduce water usage

The driving force of these systems is the microbial biofloc which can:

- Help maintain optimal water quality
- Serve as a supplemental food source

Introduction

Choosing a appropriate feed is important:

- Maximize shrimp growth
- Reduce feed cost
- Minimize negative impact on WQ

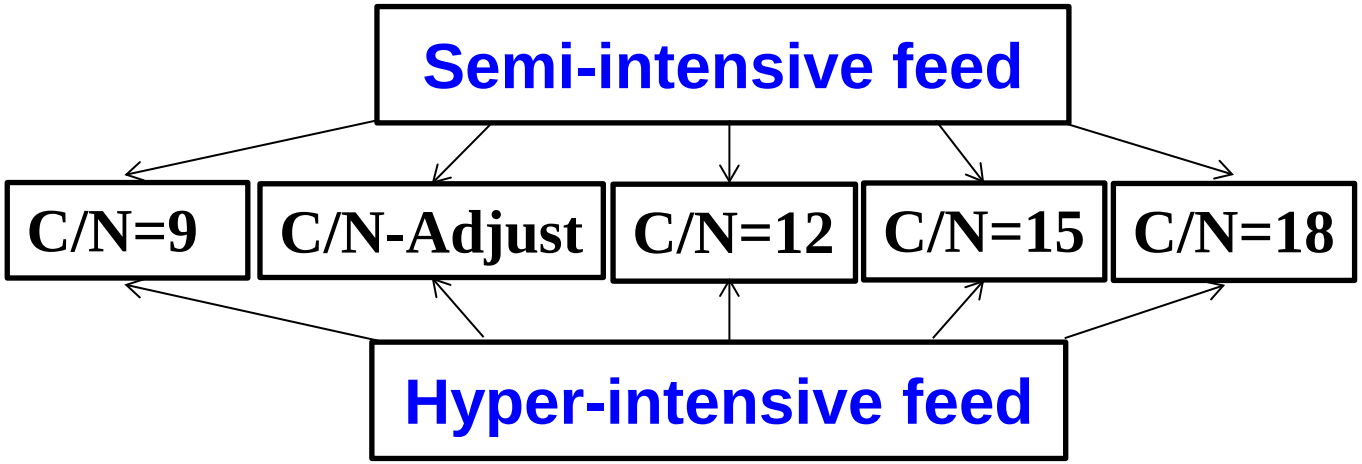
Developing microbial flocs is necessary to:

- Control nitrogen
- Recycle feed

Inoculation and adding carbohydrates are practical and effective means of enhancing the development of microbial flocs

Objectives & Experimental Design

Evaluate the effect of two commercial shrimp feeds and different C:N ratios on selected water quality indicators and shrimp performance in a biofloc-dominated zero-exchange tank system



2 × 5 Factorial Experiment Design

Materials & Methods

Juvenile *L. vannamei*

- Average weight: 2.21 ± 0.11 g
- Stocking density: 300 shrimp/m^3

Experimental system

- Forty 800-L HDPE tanks
- Equipped with 2 airstones for aeration
- Filled with biofloc-rich water (500 L)

Tank management

- No water exchange
- Freshwater was added to compensate for evaporative losses
- $NaHCO_3$ was added to maintain pH above 7.2

Materials & Methods

Feeds and Feeding

- Two 35% CP commercial feeds:
  Semi-intensive & Hyper-intensive feeds (SI-35 & HI-35)
- Feed offered in two equal portions during the day:
  08:30 and 18:30
- Rations were adjusted based on feed tray observations and weekly shrimp growth sampling

Proximate composition of the two experimental feeds (% dry weight basis)

	Crude protein	Crude fat	Crude fiber	Ash	Moisture
SI-35	35.8	9.86	2.69	11.11	7.97
HI-35	36.1	7.30	1.61	9.55	9.07

Materials & Methods

Carbohydrate supplementation

- C/N: 9, 12, 15, 18 based on the carbon and nitrogen contents of the feeds and molasses, respectively
- The C/N: Adjust treatment was based on the actual TAN in the culture water (6 g of C was added for each 1 g of TAN)
- 35% CP commercial feed had C/N=9

Water quality monitoring

- Temperature, salinity, dissolved oxygen, and pH were recorded twice daily
- SS, TSS, VSS, NH_4-N, NO_2-N, NO_3-N, alkalinity, $cBOD_5$, and turbidity were measured weekly

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Materials & Methods

Shrimp performance

- Survival (%) = 100 × (final shrimp count / initial shrimp count)
- Weekly growth rate (g/week) = (final average weight − initial average weight) / culture weeks
- Biomass = total harvest shrimp weight / water volume
- FCR = total dry weight of feed offered / total shrimp wet weight gained

Results

Water quality

A Two-way Linear Mixed Model showing the effects of feed and C/N ratio on selected water quality parameters during 6-week study with *L. vannamei*

Variables	Significant† (*P* value)		
	Diet	C/N	Diet × C/N
SS	NS (0.382)	*** (0.000)	NS (0.942)
TSS	*** (0.000)	*** (0.000)	NS (0.686)
VSS	** (0.002)	*** (0.000)	NS (0.797)
TAN	NS (0.977)	NS (0.514)	NS (0.988)
NO_2-N	NS (0.914)	* (0.014)	NS (0.842)
NO_3-N	NS (0.972)	*** (0.000)	NS (0.686)
Alkalinity	* (0.043)	*** (0.000)	NS (0.984)
$cBOD_5$	* (0.046)	** (0.003)	NS (0.389)
Turbidity	NS (0.985)	*** (0.000)	NS (0.143)

† ***P* < 0.05; ****P* < 0.01; ***** *P* < 0.001; NS, not significant.

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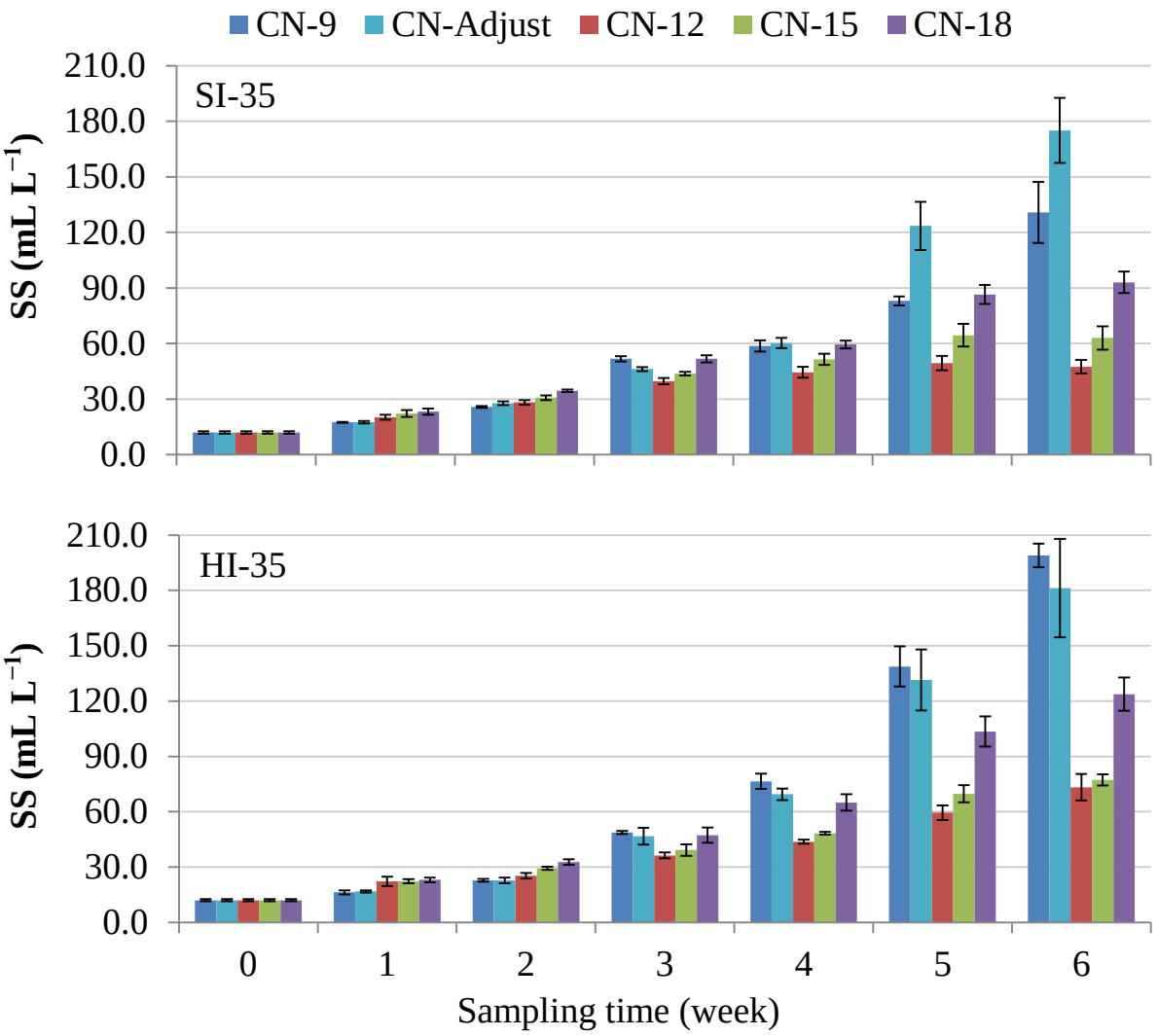
Results

Water quality



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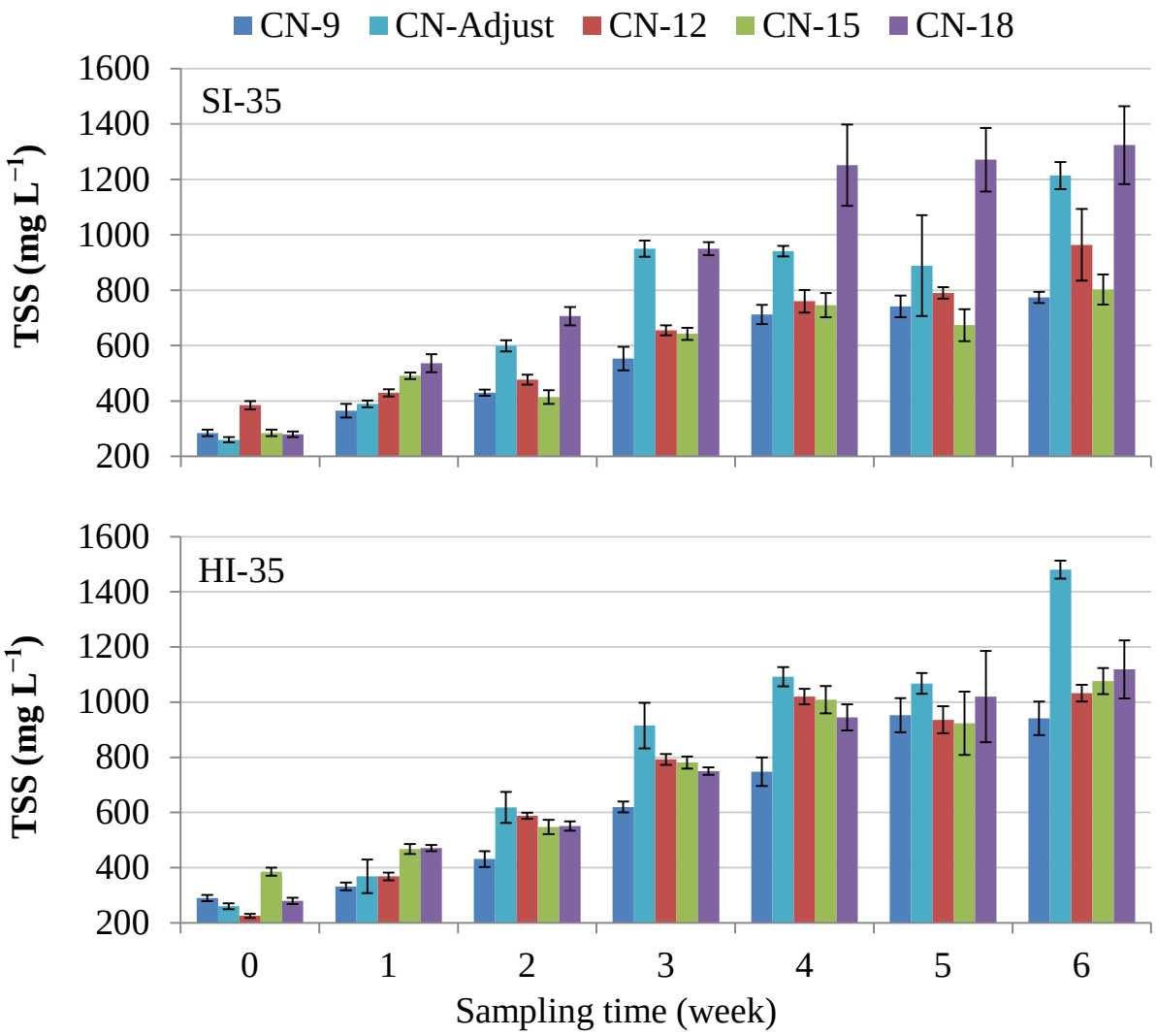
Results

Water quality



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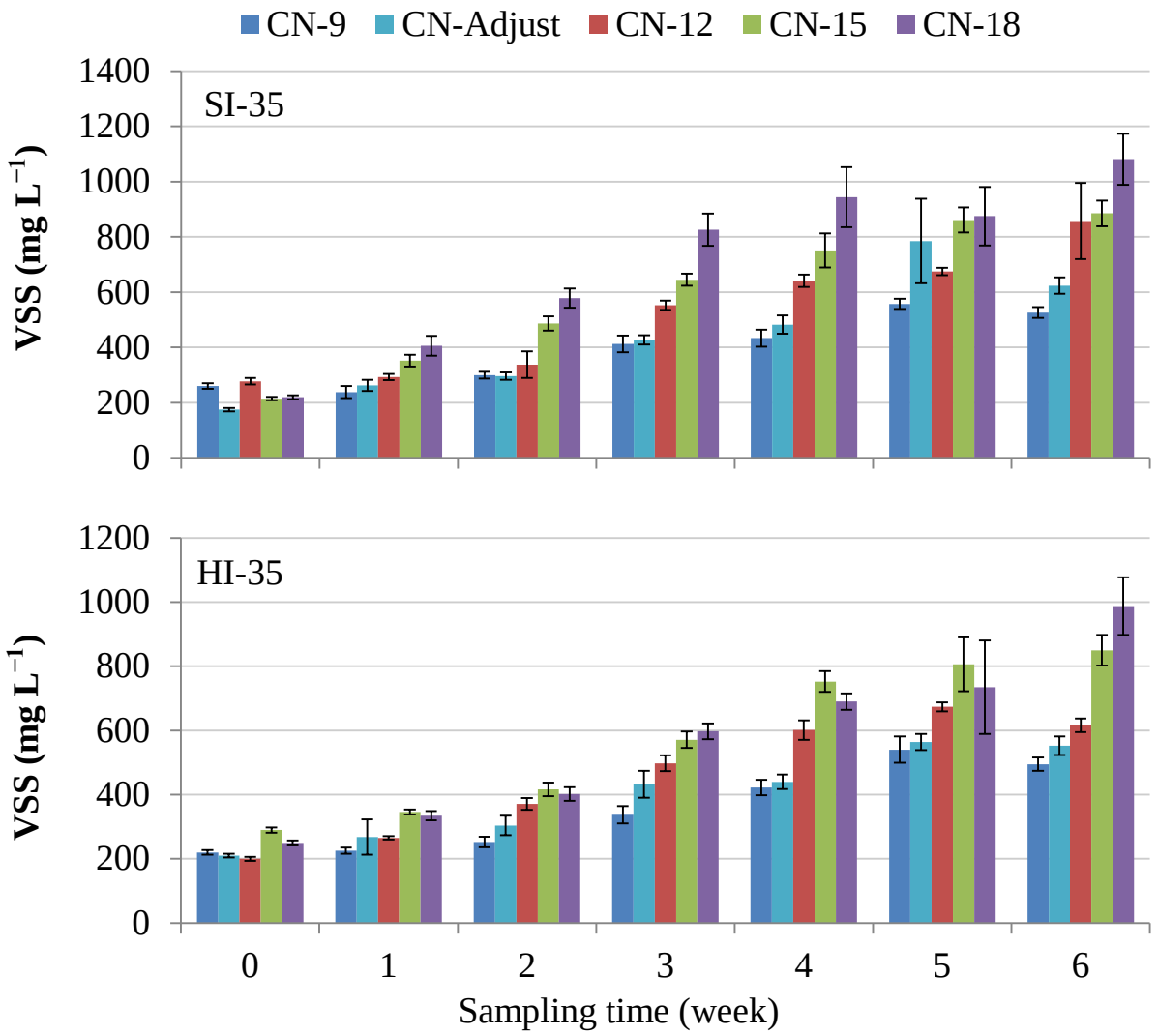
Results

Water quality



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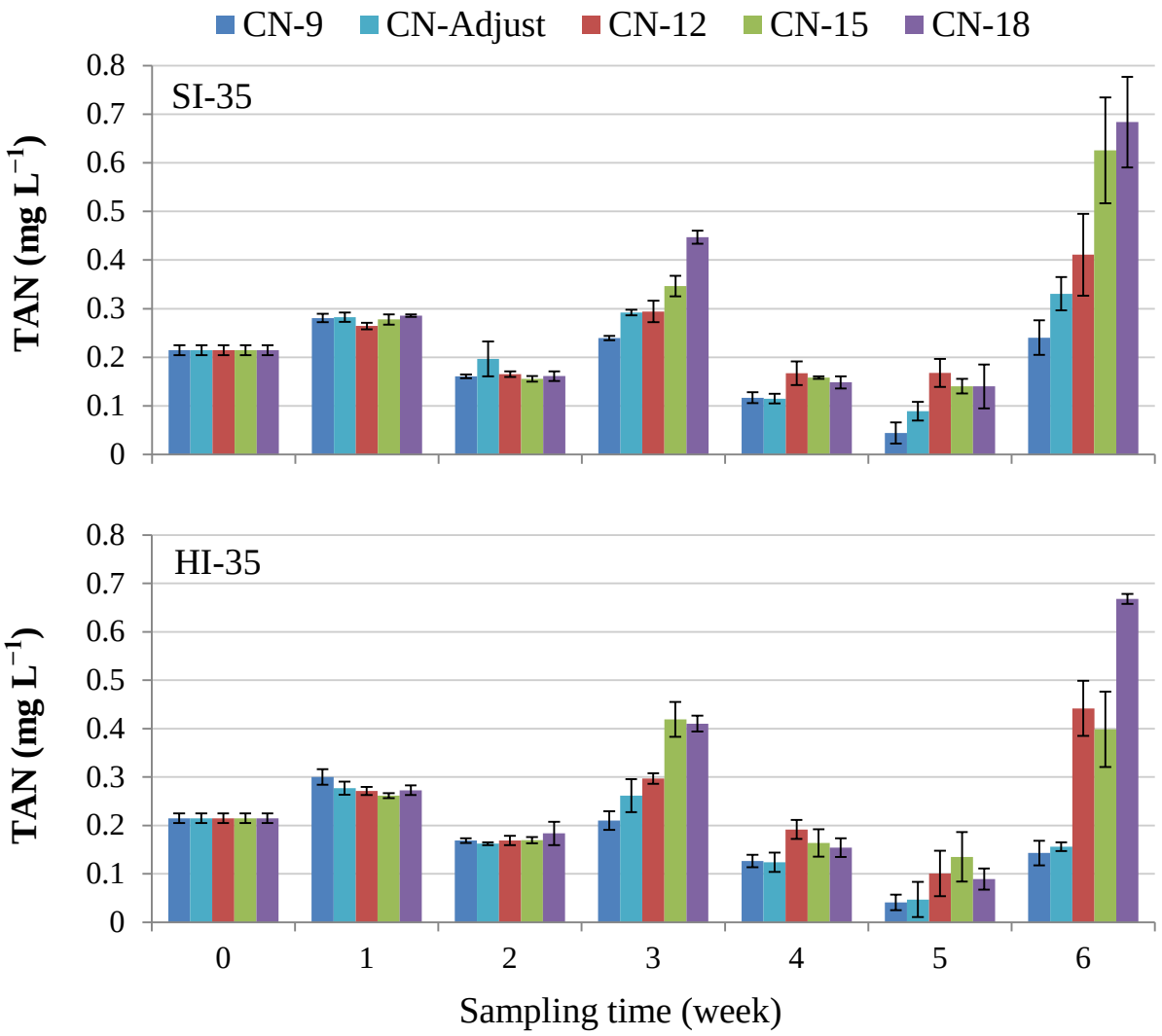
Results

Water quality



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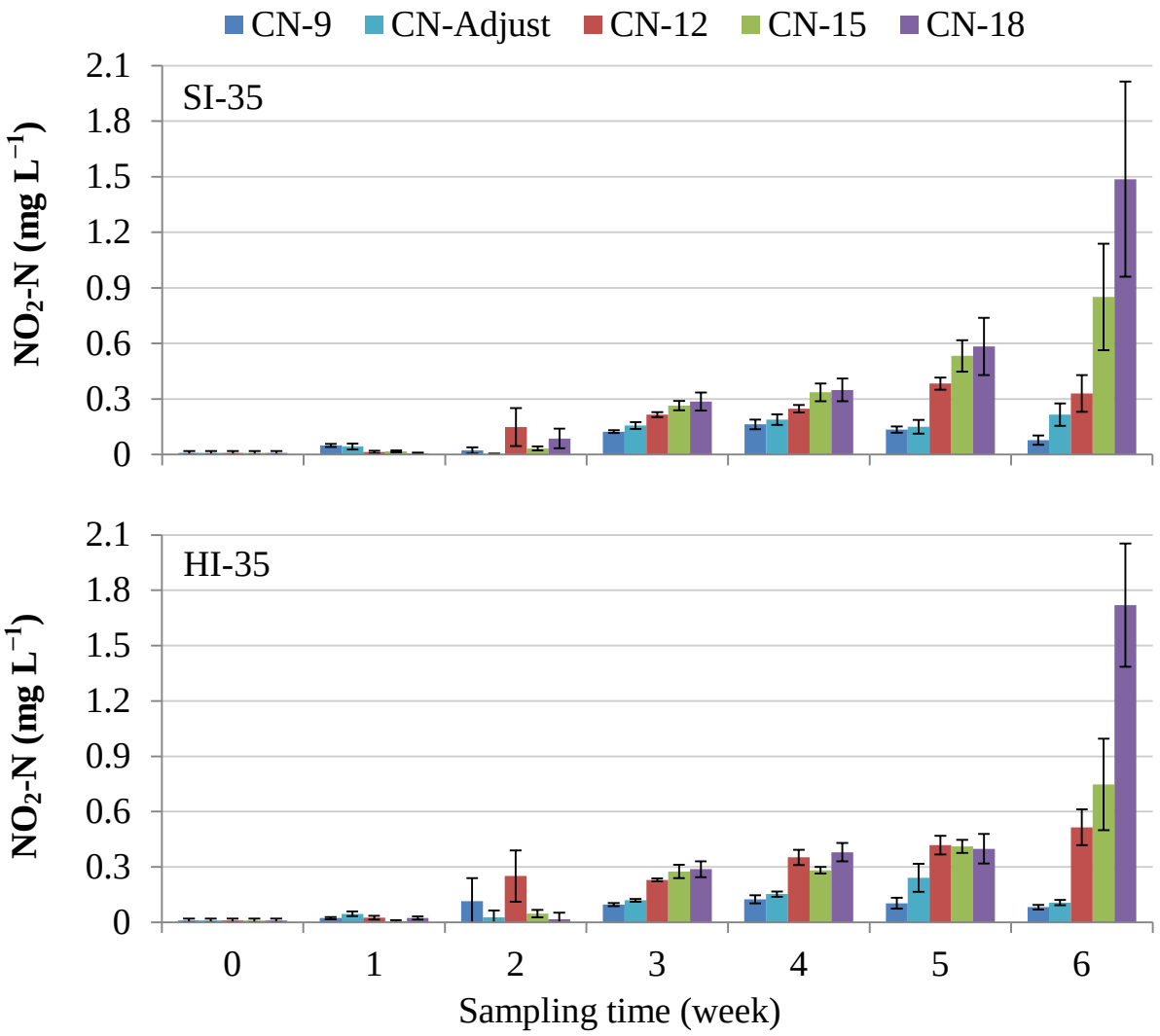
Results

Water quality



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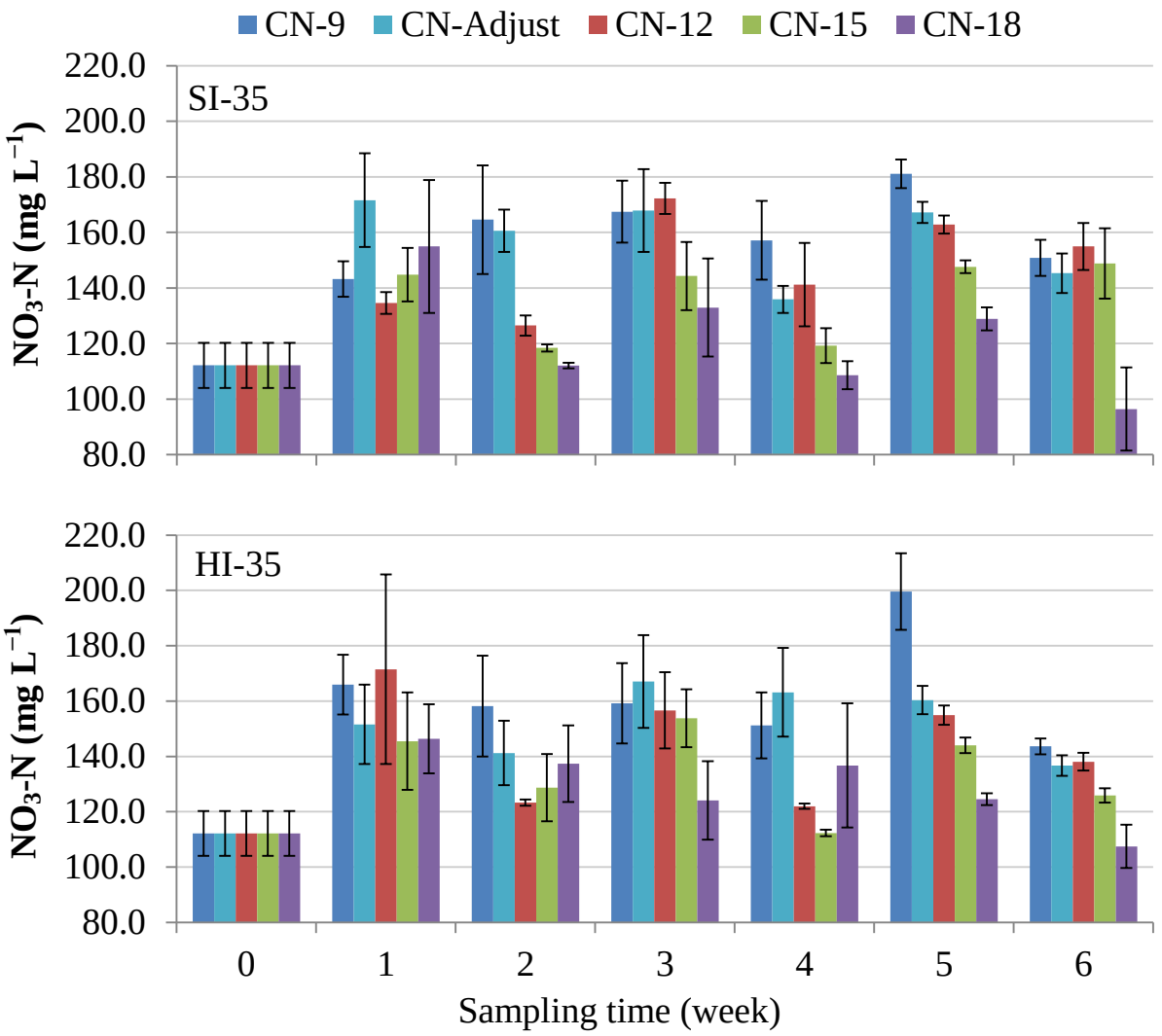
Results

Water quality



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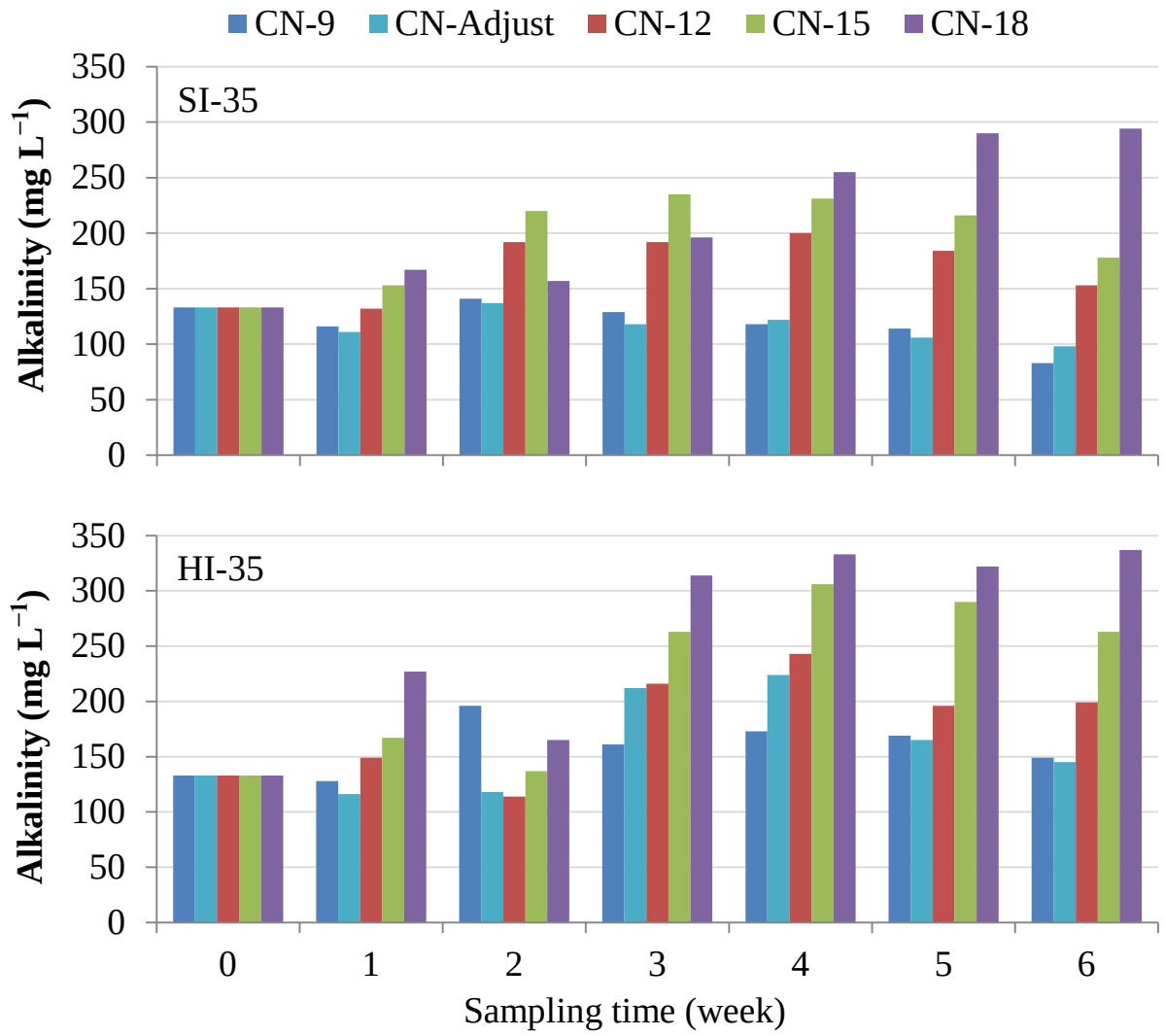
Results

Water quality



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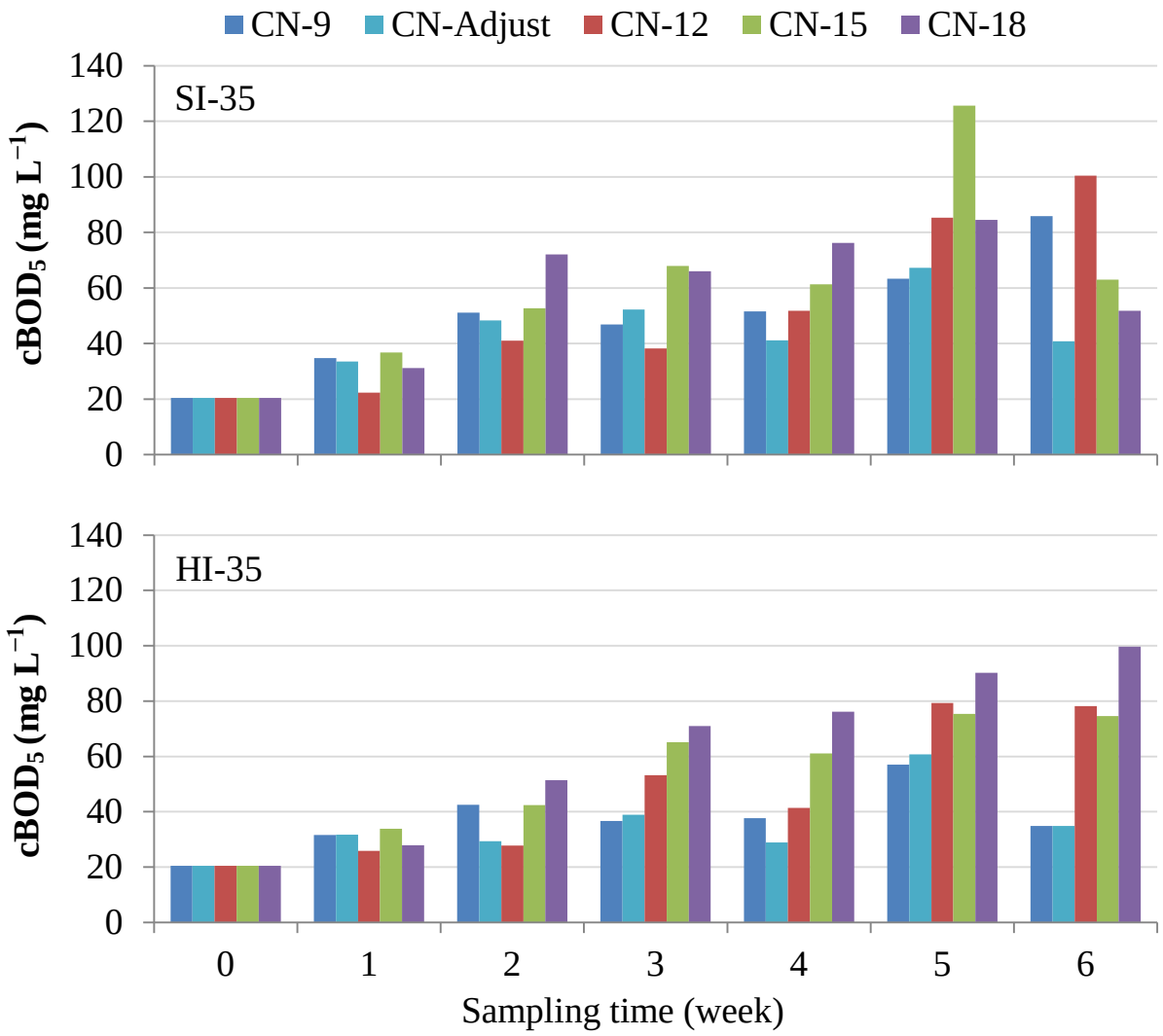
Results

Water quality



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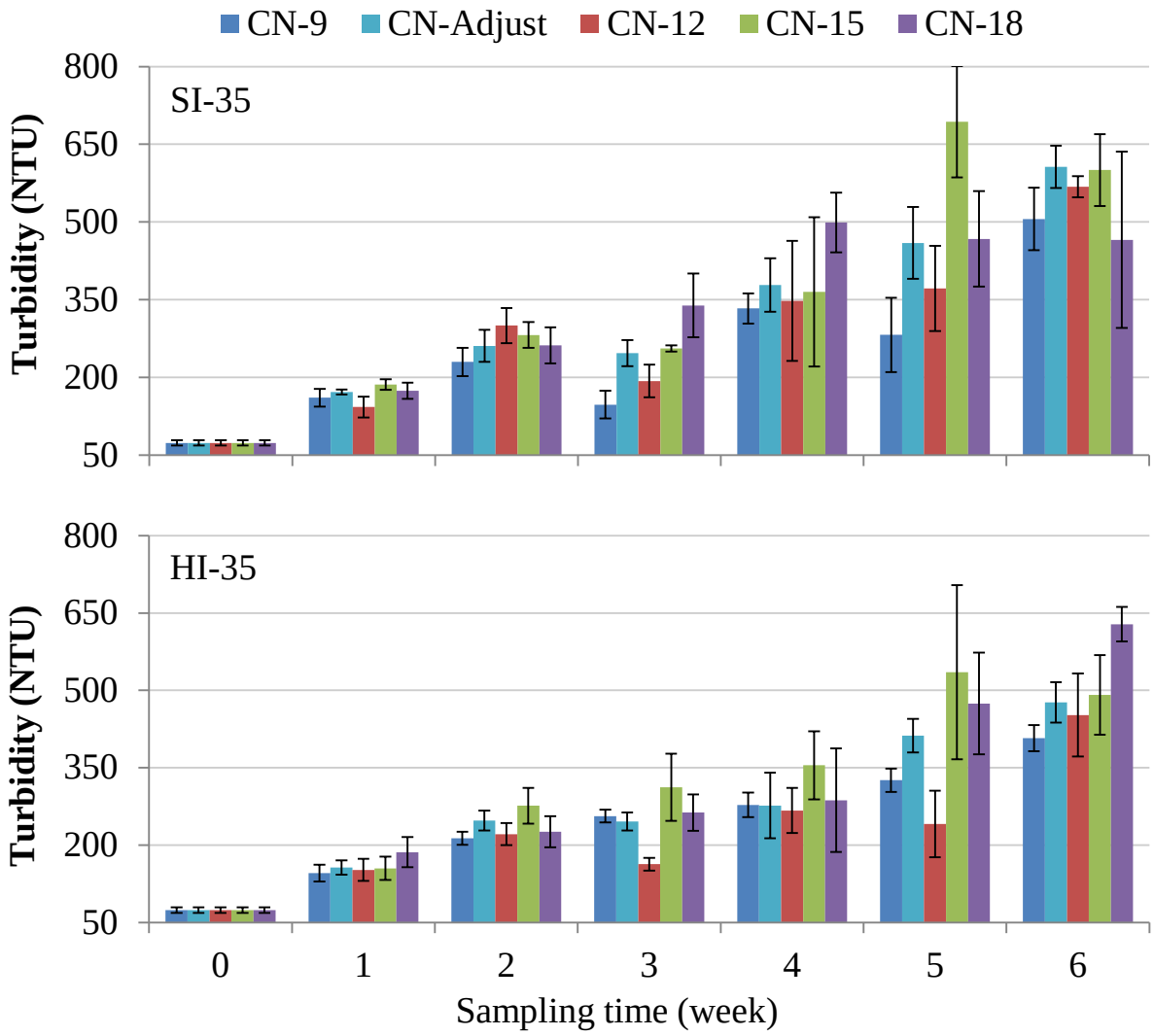
Results

Water quality



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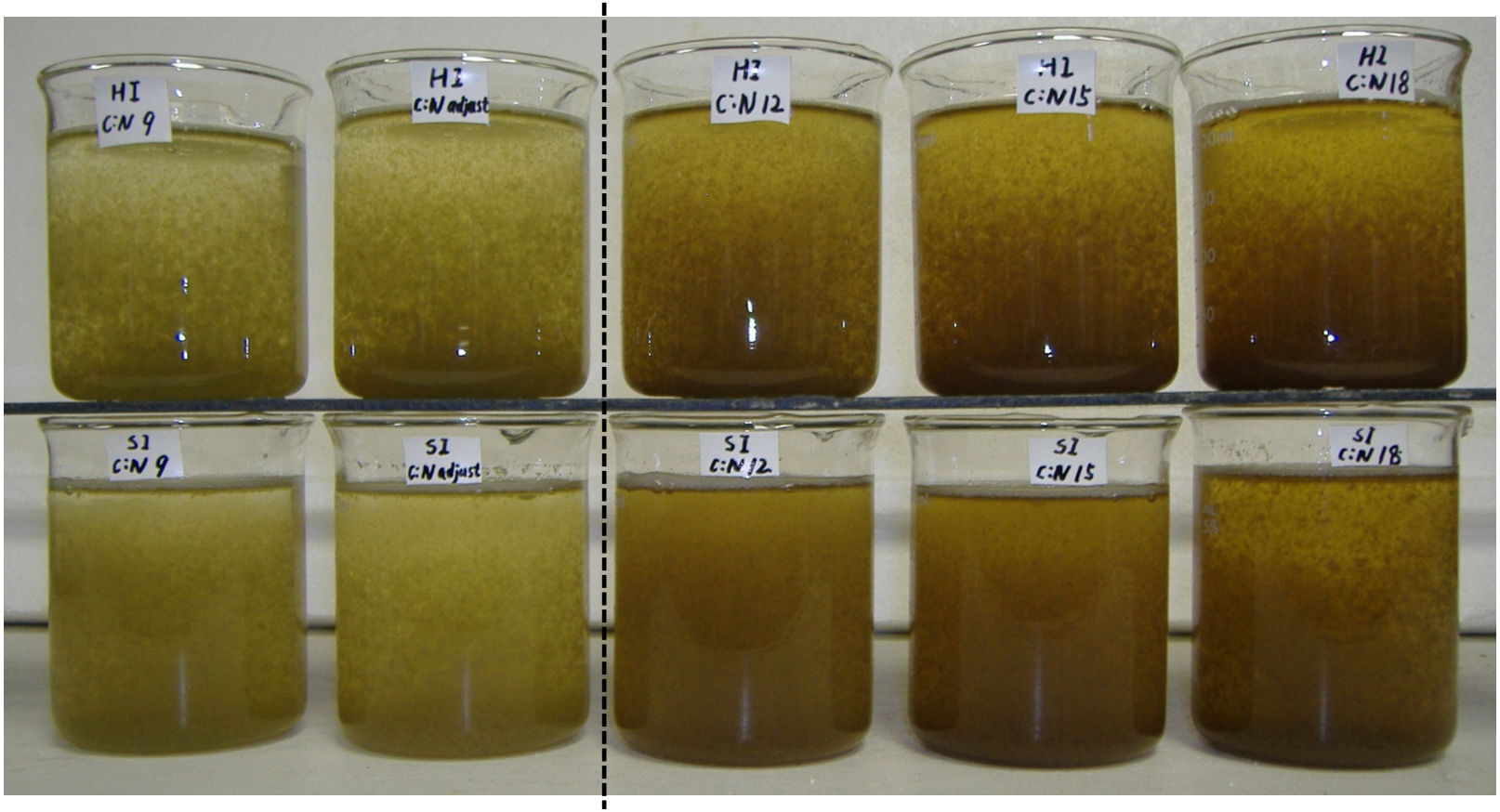
Results

Water quality



C/N < 12 **C/N ≥ 12**

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Results

Shrimp performance

Two-way Repeated Measures ANOVA showing the effects of feed and C/N ratio on shrimp performance at the end of 6-week study

Variables	Significant† (*P* value)		
	Diet	C/N	Diet × C/N
Final weight	*** (0.000)	*** (0.000)	NS (0.591)
Growth rate	*** (0.000)	*** (0.000)	NS (0.575)
Survival	* (0.041)	** (0.004)	NS (0.556)
Yield	*** (0.000)	*** (0.000)	NS (0.619)
FCR	*** (0.000)	*** (0.000)	NS (0.956)

† ***P* < 0.05; ****P* < 0.01; ***** *P* < 0.001; NS, not significant.

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Results

Shrimp performance

Means ± S.D. of final weight, growth, survival, yield, and FCR of *L. vannamei* at the end of 6-week study

	Final Wt. (g)	Growth (g /wk)	Survival (%)	Yield (kg m^{-3})	FCR
SI-35					
CN-9	8.52 ± 0.26 ^{ab}	1.05 ± 0.04 ^{ab}	98.50 ± 2.62 ^{ab}	2.46 ± 0.06 ^{b}	1.55 ± 0.02 ^{ab}
CN-Adjust	8.51 ± 0.14 ^{ab}	1.05 ± 0.06 ^{ab}	99.33 ± 1.46 ^{b}	2.48 ± 0.04 ^{b}	1.54 ± 0.02 ^{a}
CN-12	8.75 ± 0.18 ^{b}	1.09 ± 0.04 ^{b}	96.67 ± 0.36 ^{a}	2.48 ± 0.02 ^{b}	1.52 ± 0.01 ^{a}
CN-15	8.24 ± 0.36 ^{ab}	1.01 ± 0.02 ^{ab}	98.83 ± 0.26 ^{ab}	2.39 ± 0.10 ^{ab}	1.62 ± 0.08 ^{ab}
CN-18	8.09 ± 0.46 ^{a}	0.98 ± 0.06 ^{a}	96.00 ± 2.18 ^{a}	2.27 ± 0.08 ^{a}	1.71 ± 0.06 ^{b}
HI-35					
CN-9	9.84 ± 0.28 ^{bc}	1.27 ± 0.04 ^{c}	97.33 ± 0.36 ^{a}	2.81 ± 0.08 ^{b}	1.29 ± 0.08 ^{b}
CN-Adjust	9.75 ± 0.36 ^{bc}	1.26 ± 0.02 ^{bc}	97.50 ± 0.76 ^{a}	2.79 ± 0.10 ^{b}	1.30 ± 0.10 ^{b}
CN-12	9.99 ± 0.22 ^{c}	1.30 ± 0.02 ^{c}	96.50 ± 2.12 ^{a}	2.83 ± 0.02 ^{b}	1.27 ± 0.02 ^{b}
CN-15	9.20 ± 0.16 ^{ab}	1.17 ± 0.06 ^{ab}	97.83 ± 0.30 ^{a}	2.64 ± 0.04 ^{a}	1.40 ± 0.04 ^{a}
CN-18	9.03 ± 0.36 ^{a}	1.14± 0.08 ^{a}	95.67 ± 1.64 ^{a}	2.53 ± 0.12 ^{a}	1.47 ± 0.12 ^{a}

Each value represents mean ± S.D. (n = 4).
For each feed, values in the same row with different superscripts are significantly different ($P < 0.05$) based on Tukey HSD test.

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Summary

- No significant differences in inorganic N species (TAN, NO_2-N, NO_3-N) between the two feeds
- Growth & FCR of shrimp fed the HI-35 was significantly better than with the SI-35
- C/N ratio affected microbial communities
  - C/N ratio ＜12→dominated by algae (**green-water**)
  - C/N ratio ＞12→dominated by heterotrophic bacteria (**brown-water**)
  - C/N ratio ＞12→increase in biofloc volume with the increase in C/N ratio
- Higher C/N ratio resulted in lower NO_3-N concentrations and greater biofloc volume
- C/N ratio of 12 showed best shrimp performance in both feeds

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