EFFECT OF ADDITION OF *Navicula* sp. AND *Brachionus plicatilis* ON GROWTH OF *Litopenaeus vannamei* POSTLARVAE REARED IN CULTURE TANKS WITH ZERO WATER EXCHANGE

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Fevereiro
2015

Shrimp production in Brazil (ABCC, 2013)

Tabela 1: Dimensão da Carcinicultura Nacional

Variáveis Levantadas/Ano	2004	2011			Variação entre 2004 e 2011 (%)
		Em operação	Inoperante	Total	
Nº de Produtores	997	1.222	323	1.545	55%
Área Total (Ha)	16.598	19.845	2.502	22.347	35%
Produção (Ton)	75.904	69.571	-	69.571	-8%
Produtividade (Ton/Ha/Ano	4,51	3,51	-	3,51	-22%
Exportações (U$/Milhões)	$ 198,00	$ 0,90	-	$ 0,90	-99,5%

Intensive Nursery

Tabela 4: Uso de Tecnologias por Tamanho do Produtor em Operação

Categorias	Nº Produtores	Comedouros Fixos		Análise Presuntivas		Uso de Probióticos		Uso de Aeradores		Realiza Análises Hidrológicas		Uso de Berçários Intensivos	
		Nº	%	Nº	%	Nº	%	Nº	%	Nº	%	Nº	%
Micro	717	533	74%	159	22%	120	17%	224	31%	62	9%	14	2%
Pequeno	184	159	86%	84	46%	95	52%	108	59%	55	30%	22	12%
Médio	245	236	96%	151	62%	134	55%	150	61%	122	50%	65	27%
Grande	76	71	93%	65	86%	59	78%	35	46%	51	67%	48	63%
Total	1.222	999	82%	459	38%	408	33%	517	42%	290	24%	149	12%

Intensive nursery culture in Brazil

- Nursery 1 = Nursery tank
- Until PL10 or until PL20

- Nursery 2 = Nursery pond
- Until PL10 – 2 or 4 g
- Until PL20 – 2 or 4 g

- Growth Ponds: until 7 or 12g (75 %)

Models

- Monophasic: Direct recruitment for growth ponds

  Minor and micro producers

- Biphasic: Nursery tank for growth ponds

  Medium and major producers

  Nursery pond for growth ponds

  Major producers

- Triphasic: Nursery tank + Nursery pond for growth ponds

  Major producers

Intensive nursery management

Transportation:
Density 800 -1000 PL10 / L

Acclimation

Control of parameters

Different types of aeration

Fertilization N:P

Algae blooms

Diatoms

PRODUCTION IN NURSERY TANKS

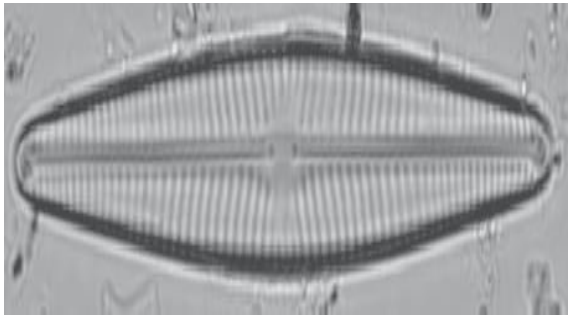
- Density: 10 or 30 PLs/L
- Culture time: 10 or 20 dias
- Survival: > 90 %

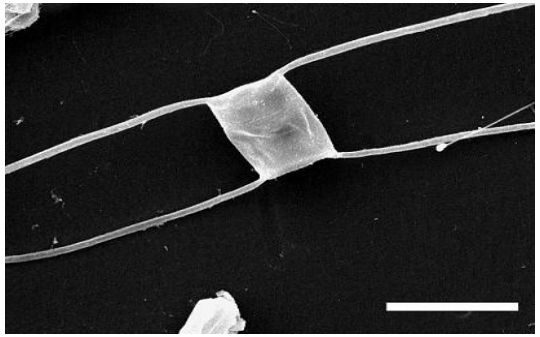
- **Final weigth: 30 to 50 mg.**

PRODUCTIONS IN NURSERY PONDS

- Density: 500 – 1000 /m2
- Culture Time: 30 to 50 days
- Survival: > 85 %

- **Final weigth: 1 to 2 g.**





- Various types of nutritional elements were observed in bioflocs as crude protein and lipid, including polyunsaturated fatty acids (PUFAs), minerals and vitamins (Ekasari, Crab & Verstraete 2010, Xu & Pan 2013a).

- The nutritional value may be influenced by the microorganisms composition of the flocs (Ju, Forster, Conquest, Dominy, Kuo & Horgen 2008; Ju, Forster & Dominy 2009),

- **BFT** **PLANKTON ADDITION ?**

The diatoms can contribute qualities such as essential amino acids (Ju et al. 2008, 2009) and highly unsaturated fatty acids (Martins, Odebrecht, Jensen, D'Oca & Wasielesky Jr. 2014).

The *Brachionus plicatilis* also can contribute qualities such as essential amino acids and highly unsaturated fatty acids, with 480-590 crude protein 61-142 g of lipids per kilogram of dry matter, and the profile of PUFAs included 25–35 g EPA and 63–311 g DHA for each kilogram of total fatty acids (Demir & Dijen, 2011a,b; Jeeja, Joseph & Raj 2011).

Lat. Am. J. Aquat. Res., 42(3): 427-437, 2014
DOI: 103856/vol42-issue3-fulltext-4

Research Article

Effect of addition of *Navicula* sp. on plankton composition and postlarvae growth of *Litopenaeus vannamei* reared in culture tanks with zero water exchange

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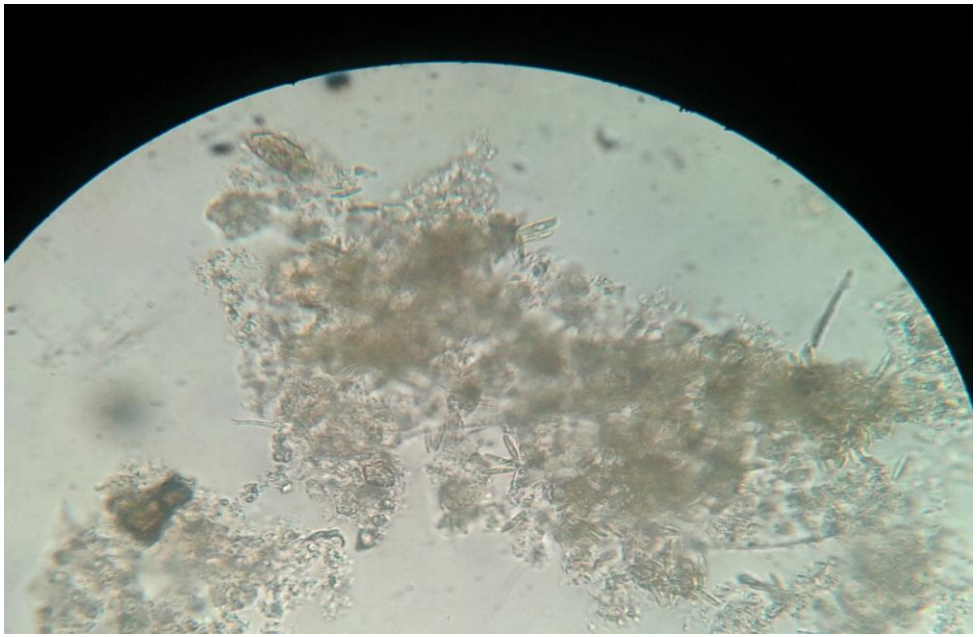
Navicula sp. 1 Kg

- 494 g P.B;
- 259 g Lipids;
- 111 g de Carboidrates;
- 82 g EPA;
- 22 g DHA;

(Khatoon et al. 2009) **P.U.F.A**



The bentonic microalgae *Navicula* sp. controls cianobacteria proliferation and is part of the biofloc.

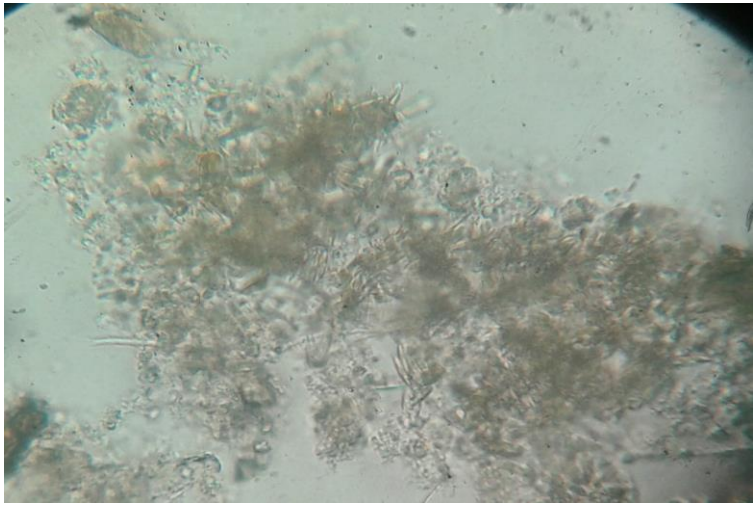


Table 5. Shrimp production parameters during the culture (20 days) of *Litopenaeus vannamei* postlarvae reared in zero water exchange, with and without feed and/or diatoms. [1]The data correspond to the mean of three replicates ± standard deviation. Mean values in same row with different superscript differ significantly ($P < 0.05$). Results from one-way ANOVA, Tukey test and Student's t-test. Zero water exchange (ZWE); ZWE with the addition of feed (ZWE-F); ZWE with the addition of *Navicula* sp. (ZWE-N) and ZWE with the addition of feed and *Navicula* sp. (ZWE-FN); SGR (% day^{-1}) = 100 x [ln final weight (g) - ln initial weight (g)] / time, and FCR: amount of feed consumed / biomass.

Parameters/ Treatments	Final weigth (mg)	Final biomass (mg)	Weight gain (mg)	Biomass gain (mg)	SGR (% day^{-1})	Survival (%)	FCR
ZWE	242 ± 31.2b	10056 ± 1297c	224 ± 31.2b	8286 ± 1297c	13.05 ± 0.65b	41.5 ± 0.70b	-
ZWE-F	272 ± 7.5b	23693 ± 658b	254 ± 7.5b	21923 ± 658b	13.66 ± 0.13b	87.0 ± 13.0a	1.2 ± 0.11a
ZWE-N	256 ± 31.5b	11278 ± 1386c	238 ± 31.5b	9508 ± 1386c	13.34 ± 0.61b	44.0 ± 2.82b	-
ZWE-FN	348 ± 41.5a	33440 ± 3992a	330 ± 41.5a	31670 ± 3992a	14.87 ± 0.61a	96.0 ± 1.41a	0.9 ± 0.22b

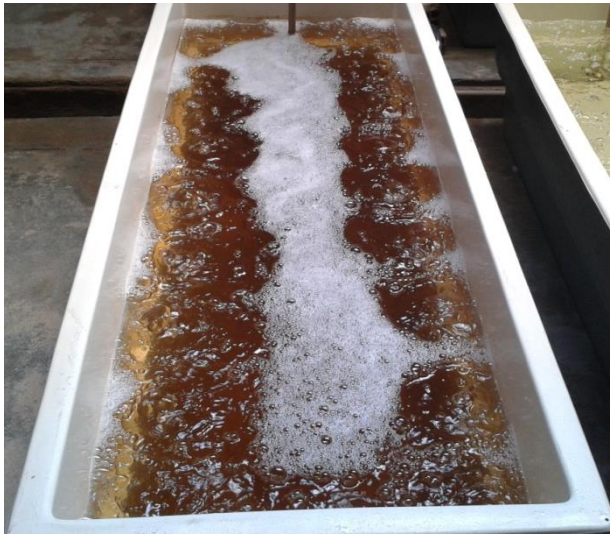
In 20 days with *Navicula* sp. PL growth increased

Final weigth: 348mg

Improved

Methods

Sustainable Mariculture Laboratory (LAMARSU) , Pernambuco Federal Rural University (UFRPE), Recife, Brazil.



Biofloc **(Control)**;

Biofloc + Addition *Navicula sp.* **(BFT-N)**;

Biofloc+ Addition *Brachionus plicatilis* **(BFT-B)**;

Biofloc + Addition *Navicula sp. a*nd *Brachionus plicatilis* **(BFT-NB)**

Water quality parameters

- Temperature
- Salinity
- pH
- Dissolved oxygen
- Total ammonia
- Nitrite – nitrogen
- Nitrate - nitrogen
- Ortophosphate
- **Settleable solids**
- Alkalinity
- **Total suspended solids**

Zootechnical parameters

- **Final weigth** .
- SGR
- Survival
- **FCR**

Statistic

- Cochran & Shapiro-Wilk Test.
- ANOVA bi factorial.
- **Kruskal-Wallis (alkalinity)**
- Student Test ($p<0,05$)
- Tukey Test ($p<0,05$)

Results and Discussion

Table 3. Proximate composition of whole body *Litopenaeus vannamei* in biofloc system, with and without the addition of *Navicula* sp. and *Brachionus plicatilis* during a 35-day experimental period.

Variables	Treatments			
	Control	BFT-N	BFT-B	BFT-NB
Moisture (%)	81.6 ± 0.2[a]	81.7 ± 0.1[a]	81.7 ± 0.2[a]	81.9 ± 0.3[a]
Crude protein	15.2 ± 0.4[b]	16.2 ± 0.3[a]	16.3 ± 0.2[a]	16.5 ± 0.3[a]
Ash	1.0 ± 0.1[a]	1.1 ± 0.1[a]	1.1 ± 0.1[a]	1.1 ± 0.2[a]

[a] Except for moisture (%), the other values are in terms of wet weight (g 100 g^{-1} wet weight).

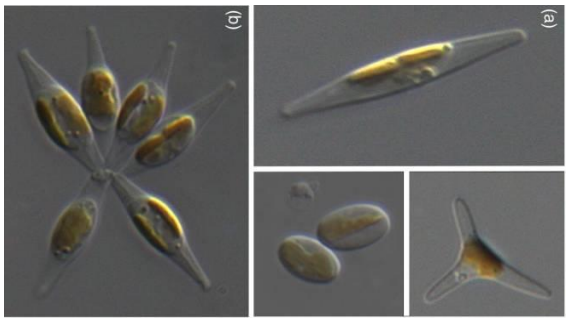
Table 1. Water quality parameters on the nursery phase of *Litopenaeus vannamei* in biofloc system, with and without the addition of *Navicula* sp. and *Brachionus plicatilis* during a 35-day experimental period.

Variables	Treatments			
	Control	BFT-N	BFT-B	BFT-NB
Morning temperature (ºC)	26.19 ± 0.09[a]	26.11 ± 0.17[a]	26.26 ± 0.07[a]	26.23 ± 0.11[a]
Afternoon temperature (ºC)	27.39 ± 0.04[a]	27.51 ± 0.10[a]	27.39 ± 0.08[a]	27.40 ± 0.03[a]
Morning dissolved oxygen (mg L^{-1})	5.80 ± 0.08[a]	5.88 ± 0.07[a]	5.78 ± 0.07[a]	5.80 ± 0.05[a]
Afternoon dissolved oxygen (mg L^{-1})	5.64 ± 0.19[a]	5.64 ± 0.23[a]	5.64 ± 0.14[a]	5.59 ± 0.08[a]
Salinity (g L^{-1})	32.9 ± 0.58[a]	32.7 ± 0.49[a]	32.7 ± 0.28[a]	32.1 ± 0.36[a]
Total ammonia nitrogen (mg L^{-1})	0.13 ± 0.08[a]	0.17 ± 0.07[a]	0.16 ± 0.07[a]	0.14 ± 0.08[a]
Nitrite–nitrogen (mg L^{-1})	0.50 ± 0.14[a]	0.44±0.18[a]	0.48 ± 0.12[a]	0.46 ± 0.11[a]
Nitrate-nitrogen (mg L^{-1})	2.70 ± 1.37[a]	2.37 ± 1.33[a]	2.36 ± 1.15[a]	2.62 ± 1.37[a]
Alkalinity (mg $CaCO_3$ L^{-1})	125.5 ± 13.1[a]	154.9 ± 19.8[a]	135.08 ± 30.0[a]	149.7 ± 27.8[a]
pH	8.16 ± 0.14[a]	8.26 ± 0.11[a]	8.20 ± 0.05[a]	8.20 ± 0.10[a]
Orthophosphate (mg L^{-1})	2.51 ± 0.12[a]	2.21 ± 0.11[a]	2.37 ±0.10[a]	2.32 ± 0.10[a]
Total suspended solids (mg L^{-1})	335.2 ± 124.93[a]	301.9 ± 97.85[a]	279.1 ± 67.62[a]	317.1 ±89.3[a]
Settleable solids (ml L^{-1})	6.4 ± 0.80[a]	5.9 ± 0.60[a]	5.7 ± 0.80[a]	6.0 ± 0.65[a]

Table 2. Zootechnical parameters on the *Litopenaeus vannamei* in biofloc system, with and without the addition of *Navicula* sp. and *Brachionus plicatilis* during a 35-day experimental period.

Zootechnical parameters	Treatment			
	Control	BFT-N	BFT-B	BFT-NB
Final weight (g)	0.68 ± 0.02^{b}	0.81 ± 0.12^{b}	0.82 ± 0.09^{b}	1.08 ± 0.10^{a}
Survival (%)	71.3 ± 5.7^{a}	85.3 ± 12.3^{a}	86.0 ± 10.4^{a}	91.7 ± 7.37^{a}
Yield (Kg m^{3})	1.21 ± 0.13^{b}	1.76 ± 0.51^{ab}	1.76 ± 0.27^{ab}	2.46 ± 0.17^{a}
FCR	1.94 ± 0.20^{a}	1.37 ± 0.35^{ab}	1.32 ± 0.20^{b}	0.92 ± 0.06^{b}
SGR (% day^{-1})	8.91 ± 0.08^{b}	9.41 ± 0.41^{b}	9.44 ± 0.31^{b}	10.23 ± 0.25^{a}
PER	1.30 ± 0.14^{c}	1.93 ± 0.18^{b}	1.93 ± 0.13^{b}	2.73 ± 0.19^{a}

The data correspond to the mean of three replicates ± standard deviation. Results from one-way ANOVA and Tukey test. Mean values in the same row with different superscripts differ significantly ($P < 0.05$).



- Some plankton community like diatoms and rotifers provide important nutritional compounds, such as essential amino acids and highly unsaturated fatty acids that are essential to shrimp survival and growth (Jú *et al*. 2008, 2009; Khatoo *et al*. 2009; Demir & Dijen, 2011a,b; Jeeja *et al*. 2011; Martins *et al*. 2014)

- The highest yield (1.76-2.46 Kg m^3) and lower FCR (0.92-1.37) in biofloc with plankton addition showed that *Navicula* sp. and *B. plicatilis* are a significant food source for postlarvae shrimp. Microbial community present in biofloc system significantly improved weight gain and FCR of shrimp, thus potentially reducing the feed cost associated with shrimp production (Avnimelech 2009)

- *Navicula saprophila* displayed the greatest productivity of EPA and the EPA content of its biomass was enhanced under mixotrophic conditions (Kitano, Matsukawa & Karube 1997, 1998).

- The *B. plicatilis* also could change proximal composition with different microalgae food and commercial enrichment products (Demir & Dijen, 2011a,b; Jeeja, Joseph& Raj 2011).

- The moisture, crude lipid and ash content found in our experiments were similar to those reported by Brito, Chagas, Silva, Soares, Severi & Gálvez (2014) with C:N 12:1.

Conclusions

- The addition of the bentonic diatom *Navicula* sp. and the rotipher *Brachionus plicatilis* increased the growth of postlarvae *L. vannamei* and improved the FCR in a zero water exchange system.

- These diatoms and rotiphers provide a significant natural food source for shrimp in their early stage.


Thanks
Gracias
Obrigado.