Effects of artificial substrate and night-time aeration on the water quality in *Macrobrachium amazonicum* (Heller 1862) pond culture

Matheus Nicolino Peixoto Henares¹,², Bruno de Lima Preto¹,³, Fabricio Ribeiro Tito Rosa¹, Wagner Cotroni Valenti¹,⁴ & Antonio Fernando Monteiro Camargo¹,⁵

¹Centro de Aquicultura da Universidade Estadual Paulista (Caunesp), Jaboricabal, São Paulo, Brasil
²Centro Universitário da Fundação Educacional de Barretos – UNIFEB, Barretos, São Paulo, Brasil
³Instituto Federal do Espírito Santo – IFES, Alegre, Espírito Santo, Brasil
⁴Campus Experimental do Litoral Paulista – CLP, Universidade Estadual Paulista, São Vicente, São Paulo, Brasil
⁵Departamento de Ecologia, Campus de Rio Claro, Universidade Estadual Paulista, São Paulo, Brasil

Correspondence: A F M Camargo, Departamento de Ecologia, Universidade Estadual Paulista, Campus Rio Claro, Avenida 24-A, 1515, 13506-900 Rio Claro, SP, Brazil. E-mail: afmc@rc.unesp.br

**Abstract**

The effects of artificial substrate and night-time aeration on the culture of *Macrobrachium amazonicum* were evaluated in 12 ponds stocked with 45 prawns m⁻². A completely randomized design in 2 × 2 factorial scheme with three replicates was used. The combination of factors resulted in four treatments: with substrate and aeration (SA), with substrate and without aeration (SWA), without substrate and with aeration (WSA) and without substrate and aeration (WSWA). The presence of substrate in SA and SWA treatments reduced suspended particles (seston) by ~17.3% and P-orthophosphate by ~50%. The use of aerator (WSA and SA treatments) significantly (P < 0.05) increased the concentration of dissolved oxygen, suspended particles and nutrients in the pond water. These results indicate that the effect of substrate on turbidity and total suspended solids (TSS) values is opposite to the effect of the aerator. The aerators in semi-intensive grow-out *M. amazonicum* farming lower water quality because they increased the amount of detritus and nutrients in the pond water. On the other hand, the use of artificial substrate reduces turbidity values, chlorophyll a, TSS and P-orthophosphate concentrations. Therefore, the combination of substrate addition and night-time aeration is not interesting because they have opposite effects.

**Keywords:** limnology, nitrogen, phosphorus, crustacean, freshwater prawn

**Introduction**

The Amazon river prawn (*Macrobrachium amazonicum*) is a native species from South America where it is widely distributed in the lakes, reservoirs, floodplains and rivers in tropical and subtropical regions of this continent. The *M. amazonicum* has a great potential for aquaculture because it may adapt well for intensive or extensive farming, presents less aggressive behaviour and ability to grow in reservoirs, ponds and fishponds (Maciel & Valenti 2009). Besides, the culture of *M. amazonicum* where this species is native is an alternative that avoids environmental impacts due to escapes and the establishment of exotic species in the natural environment (Morais-Valenti & Valenti 2010). Many studies on the culture of this species have been performed during the past decade (see Maciel & Valenti 2009 and Morais-Valenti & Valenti 2010). However, research should still be performed to allow the development of more efficient culture systems and management, especially to save water and increase productivity.

Productivity may be enhanced by increasing stocking density and use of substrates and aeration in static ponds, thus saving water. The substrates are natural screens (e.g. bamboo, branches) or artificial screens (e.g. screens, nets) installed inside the culture ponds to increase the production area, especially of benthic organisms. The use of substrates allows higher prawn stocking density,
reduces heterogeneous growth and agonistic behaviour as well, and improves animal welfare (Karplus & Sagi 2010). It also allows the growth of periphyton, which absorbs nitrogen and phosphorus, enhancing water quality, and provides food to the prawns (Tidwell & Bratvold 2005). Substrates can be associated with aerator use, which also allows increasing the stocking density due to the increase in oxygen in the pond water and reduces the generation of effluent (Valenti, New, Salin & Ye 2010). Some benefits of aerator use to survival and production of aquatic organisms were observed in fish farming. The survival rate of some fish species (Catla catla Hamilton, Labeo rohita Hamilton, Labeo fimbriatus Bloch and Puntius sarana Hamilton) increased from an average of 28.9% in the ponds without aeration to 57.7%, 73.6% and 81.8% in ponds with 4, 8 and 12 h of aeration respectively (Pawar, Jena & Das Bhatnagar 2009).

The production of aquatic organisms is often performed with the constant renewal of pond water to maintain water quality levels suitable for organism growth. Thus, farming without renewal of pond water reduces the release effluent and can be more efficient with the use of substrates and aeration because these techniques allow periphyton to recover the nutrients offered in the food and the oxygen concentration remains higher, especially at night. The absorption of nitrogen and phosphorus by periphyton improves the water quality (Milstein 2005). The periphyton growth on artificial substrates installed in Macrobrachium rosenbergii ponds reduced the concentration of N-NH$_3$ from 0.059 to 0.038 mg L$^{-1}$ and N-NO$_2$ from 0.075 to 0.044 mg L$^{-1}$ (Asaduzzaman, Wahab, Verdegem, Benerjee, Akter, Hasan & Azim 2009).

Studies investigated the effects of substrates on the production, water quality and periphyton development as additional food source to M. rosenbergii (Tidwell & Bratvold 2005; Asaduzzaman et al. 2009; Uddin, Azim, Wahab & Verdegem 2009). However, there are no studies investigating the combined effects of artificial substrate addition and nighttime aeration use in ponds culture of M. amazonicum without water renewal.

### Material and methods

The experiment was carried out during 122 days in 12 rectangular earthen bottom ponds with an area of 0.01 ha and an average depth of 1 m (100 m$^3$ volume) located in Jaboticabal, SP, Brazil (21°15′22″S and 48°18′48″W). The climate, according to Köppen, is Aw tropical rainy with dry winter and average temperatures in the coldest month 18°C. The rainfall during the experimental period ranged from 238 mm in January to 26.6 mm in May, 2009. The average maximum temperature was 30.0 ± 1.5°C and minimum 18.7 ± 2.2°C.

A completely randomized design 2 x 2 factorial scheme with three replicates was used. The investigated factors included additional substrate (presence and absence) and night-time aeration (presence and absence). The combination of factors resulted in four treatments (management systems for M. amazonicum grow-out): with substrate and aeration (SA), with substrate and without aeration (SWA), without substrate and with aeration (WSA) and without substrate and aeration (WSWA). In the treatments with substrate, a nylon screen mesh (30 mm) used in aquaculture to protect farmed animals from predation by birds was installed inside the ponds as substrate. The substrates (screens) were installed vertically attached to wooden poles, so that the total area was 50% of the area of the pond’s bottom. Aerators were powered between 02:00 and 05:00 hours. During the experimental period, there was no renewal of pond water. Pond inflow water was adjusted to compensate for water loss by seepage and evaporation. Therefore, no effluent water was generated during the farming of M. amazonicum prawns.

Ponds were drained and allowed to air dry for a week, and excess sediment was removed. Then, they were limed (1000 kg ha$^{-1}$ CaCO$_3$) and filled with water from a 1-ha reservoir with a depth of 1.3 m. After filling the ponds, urea and simple superphosphate were added to a final concentration of 8 kg N ha$^{-1}$ and 16 kg P$_2$O$_5$ ha$^{-1}$ respectively. At the end of 5 days, M. amazonicum juveniles with an age of 30 days and an average individual weight 0.024 ± 0.01 g were stocked at
45 prawns m$^{-2}$. Prawns were fed daily with pelleted commercial feed (35% crude protein), divided into two equal portions distributed at 08:00 and 16:00 hours every day. In the first 45 days of experiment, feed amount was 2.5 g m$^{-2}$. Thereafter, feed amount varied between 5% and 9% of the prawn biomass contained in each pond, according to the development phase. The prawn biomass was estimated every 21 days, and feed amount was corrected weekly, assuming 1% mortality and 20% weight gain per week. The mean (± standard deviation) total food supplied in the SA treatment was 56.3 ± 6.0 kg, SWA 54.7 ± 4.8 kg, WSA 53.3 ± 4.1 kg and WSWA 53.3 ± 4.1 kg, and 56.5 ± 8.5 kg. On the 122th day, the prawn production ranged from 972 ± 20 kg ha$^{-1}$ in the WSWA treatment to 1158 ± 70 kg ha$^{-1}$ in SA. No significant difference ($P < 0.05$) was observed among treatments.

The limnological variables of pond water were determined monthly, between 06:00 and 08:00 hours at a depth of 0.7 m. The methods used are shown in Table 1. At the end of the experiment, three substrate samples of $10 \times 10$ cm ($100 \text{ cm}^2$) were removed, and the material adhering to the screen was gently scraped with a blade to evaluate the dry weight (g m$^{-2}$) and nitrogen and phosphorus stock (g m$^{-2}$) in periphyton. The scrap material was placed in Petri dishes in an oven at 60°C until a constant dry weight was reached. The concentration of total nitrogen (TN) was determined using the semi-micro Kjeldahl method described in the APHA (2005), and the total phosphorus (TP) concentration (P%MS) was determined according to the method described by Allen, Grinshaw, Parkinson and Quarmby (1974). The stocks of TN and TP in the material adhering to the substrate were calculated using the following equation:

$$E = M \times C/100,$$

where $E = \text{stock (g of N or P m}^{-2})$, $M = \text{dry matter of material adhered (g m}^{-2})$ and $C = \text{TN and TP concentration in the dry matter of material adhered to the substrate (%MS)}$.

The data about the dissolved oxygen, chlorophyll $a$, turbidity, total suspended solids (TSS), N-ammonia, N-nitrite, N-nitrate, total N-Kjeldahl (TKN), P-orthophosphate and TP concentrations of pond water from the last sample (at 122 days of experiment) and the data of dry mass, TN and TP stock were analysed using the Kolmogorov–Smirnov and Bartlett tests to assess normality and homoscedasticity respectively. As these conditions were satisfied, the means of limnological variables were subjected to analysis of variance (ANOVA) with two factors (two-way ANOVA) and the means of dry mass, TN and TP stock were subjected to $t$-test. When significant differences were observed among means ($P < 0.05$), Tukey’s test was applied.

**Results**

The mean temperature in the ponds’ water was 26.0 ± 0.1°C, and mean pH values ranged from

<table>
<thead>
<tr>
<th>Limnological variables</th>
<th>Analysis methods</th>
<th>References</th>
<th>Equipment specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Digital thermometer</td>
<td>Yellow Springs Instruments (YSI) 556 MPS</td>
<td></td>
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<tr>
<td>Electrical conductivity</td>
<td>Digital conductivity</td>
<td>Yellow Springs Instruments (YSI) 556 MPS</td>
<td></td>
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<tr>
<td>Dissolved oxygen</td>
<td>Digital Oximeter</td>
<td>Yellow Springs Instruments (YSI) 556 MPS</td>
<td></td>
</tr>
<tr>
<td>Chlorophyll $a$ (mg L$^{-1}$)</td>
<td>HACH, Loveland, CO, USA</td>
<td>HACH DR/2500</td>
<td></td>
</tr>
<tr>
<td>Turbidity (UNT)</td>
<td>HACH, Loveland, CO, USA</td>
<td>HACH DR/2000</td>
<td></td>
</tr>
<tr>
<td>Total suspended solids (mg L$^{-1}$)</td>
<td>HACH, Loveland, CO, USA</td>
<td>HACH DR/2000</td>
<td></td>
</tr>
<tr>
<td>N-ammonia (µg L$^{-1}$)</td>
<td>Phenol, colorimetric</td>
<td>APHA 2005 (4500-NH$_3$ F)</td>
<td></td>
</tr>
<tr>
<td>N-nitrite (µg L$^{-1}$)</td>
<td>Colorimetric</td>
<td>APHA 2005 (4500-NO$_2$ B)</td>
<td></td>
</tr>
<tr>
<td>N-nitrate (µg L$^{-1}$)</td>
<td>Cadmium Reduction</td>
<td>APHA 2005 (4500-NO$_3$ E)</td>
<td></td>
</tr>
<tr>
<td>Total N-Kjeldahl (mg L$^{-1}$)</td>
<td>Semi-micro Kjeldahl</td>
<td>APHA 2005 (4500-N C)</td>
<td></td>
</tr>
<tr>
<td>P-orthophosphate (µg L$^{-1}$)</td>
<td>Stannous chloride (colorimetric)</td>
<td>Destilador Kjeldahl</td>
<td></td>
</tr>
<tr>
<td>Total phosphorus (µg L$^{-1}$)</td>
<td>Stannous chloride (colorimetric)</td>
<td>APHA 2005 (4500-P D)</td>
<td>HACH DR/2000</td>
</tr>
</tbody>
</table>
7.1 ± 0.2 to 7.5 ± 0.3 in water undergoing SA and WSA treatments respectively. The mean electrical conductivity value in all treatments was 0.08 ± 0.001 mS cm⁻¹. Dissolved oxygen concentrations decreased during the experiment. At the end of the experiment (94 and 122 days), the lowest concentration was observed in the SWA treatment (3.0 ± 0.2 mg L⁻¹) and the highest concentration in WSA (8.2 ± 0.3 mg L⁻¹) (Fig. 1a). The values of chlorophyll a, turbidity, TSS, N-nitrite, TKN, P-orthophosphate and TP were low in all treatments during the first 66 days of experiment. Thereafter, the values of these variables increased, reaching a maximum value at 122 days. The highest values of chlorophyll a (0.45 ± 0.05 mg L⁻¹), turbidity (77.7 ± 2.7 UNT), TSS (77.5 ± 5.8 mg L⁻¹), N-nitrite (17.7 ± 0.41 mg L⁻¹), P-orthophosphate (6.4 ± 1.2 mg L⁻¹) and TP (25.8 ± 2.5 mg L⁻¹) were observed in the WSA treatment (Fig. 1b-d, f, i and j). The highest TKN concentrations (mean 2.7 mg L⁻¹) occurred in the SA and WSA treatments (Fig. 1h).

The N-nitrate concentrations, in contrast to the other forms of nitrogen and phosphorus, decreased during the experiment in all treatments. At the end of farming, the highest value of N-nitrate concentrations was observed in the SA treatment (225.1 ± 14.8 mg L⁻¹) (Fig. 1g).

**Substrate effect**

The dissolved oxygen, chlorophyll a, turbidity, TSS and P-orthophosphate values on the last day of the experiment were significantly lower (P < 0.05) in ponds with substrate presence (Table 2). The substrate presence in the *M. amazonicum* culture reduced particles (seston) by approximately 17.3% and P-orthophosphate by 50% (Table 2).

**Aeration effect**

Aerator presence significantly increased (P < 0.05) the dissolved oxygen, particulate matter and nutrient concentration in the pond water (Table 2). The values of chlorophyll a, turbidity and TSS were 2.1, 1.3 and 1.6 times higher, respectively, in ponds with aerators than in ponds without aerators. Ponds with aerators showed N-ammonia, P-orthophosphate and N-nitrite concentrations 32%, 12% and 15% higher, respectively, in aerated treatment ponds than without aerated ponds (Table 2).

**Effect of SA interaction**

The N-nitrate concentrations were significantly higher (P < 0.05) in ponds with the presence of the two factors tested. The N-nitrate form showed a low P value for the interaction of factors (Table 2). The interaction suggests adding the effect of two factors (synergistic effect) on the N-nitrate concentration, which, at the end of the experiment, was higher in the SA treatment than in SWA and WSA (Fig. 1g). The interaction among the factors was also significant (P < 0.05) for TP, N-nitrite, TSS and chlorophyll a. The effects of substrate on the chlorophyll a, turbidity and TSS values were contrasted to the effect of the aerator; as in the ponds with the presence of substrate, the values of these variables were significantly lower, whereas in ponds with aerator, the chlorophyll a, turbidity and TSS values were significantly higher (Table 2).

The mean values (± standard deviation) of the total fresh mass of material adhered to the substrate in the SA and SWA treatments were 89.8 ± 3.4 kg and 34.3 ± 11.2 kg respectively. The dry mass was significantly higher (P < 0.05) in the SA treatment. The amounts of TN in periphyton in both treatments (SA and SWA) were similar, but the TP amount was significantly higher (P < 0.05) in the SA treatment than in the SWA treatment (Table 3).

**Discussion**

At the beginning of the experiment, the presence of substrate and aerator had no effects on the ponds’ water because the limnological characteristics were similar in all treatments. The values of turbidity, chlorophyll a, TSS, nitrogen and phosphorus were lower at the beginning because the stocked prawn biomass and supplied food were low (Fig. 1b-j). However, during the experiment, the gradual increase in prawn biomass and the amount of supplied food caused the reduction in dissolved oxygen concentration and increased turbidity, TSS, nitrogen and phosphorus values. The high values of limnological variables (except N-nitrate) at the end of farming indicate that the increase in detritus and nutrients have a positive relationship with the increasing biomass of *M. amazonicum*. Positive linear relationships among the increases in the prawn biomass as well as the inorganic nitrogen, TKN and TP concentrations
Figure 1 Mean values (n = 3) and standard deviations of limnological variables of pond water with the substrate and aeration (SA) (●); with substrate and without aeration (SWA) (▲); without substrate and with aeration (WSA) (■); and without substrate and aeration (WSWA) (▲).
were reported by Biudes, Camargo and Henares (2011) in a broodstock pond of *M. rosenbergii*. In the marine shrimp *Penaeus latissulcatus* culture, the increasing P-orthophosphate and TP concentrations were positively correlated with the increase in supplied food from 3 to 7.5% of biomass (Le, Fotedar & Kumar 2012).

The increase in the prawn biomass and the food supplied increased the detritus and phosphorus concentrations in all treatments, but in aerated ponds (SA and WSA treatments), detritus and phosphorus concentrations were higher. The detritus is formed from the unconsumed food, faeces, debris of dead animals and plankton. The solid suspension in pond water occurs naturally due to the movement of prawns, as reported by Kimpara, Rosa, Preto and Valenti (2010) in the culture of *M. amazonicum*. The bioturbidity increases the solids suspended in water and promotes the exchange of particles, ions and nutrients between the sediment and water column (Adámek & Marsálek 2012). However, the pond water aeration enhances this process and may intensify the exchanges between the sediment and water column. It is confirmed by higher turbidity, TSS and nutrients concentration in ponds with aeration. Besides increased detritus and nutrient suspension due to aeration, the increasing of oxygen concentration in the surface layer of the sediment water favours the release of nutrients into the water column due to aerobic decomposition and mineralization of organic matter carried out by benthic macroinvertebrates (e.g. Chironomidae, Chaoboridae, Olygochaeta) (Phan-Van, Rousseau & De Pauw 2008; Lagazauere, Moreira & Koschorreck 2011). The higher availability of nutrients in the ponds with aeration probably favoured the growth of phytoplankton and periphyton. The periphyton dry mass was 1.8 times higher in the SA treatment (9547 g m$^{-2}$) than the SWA treatment (5179 g m$^{-2}$) and chlorophyll $a$ concentrations were average 52% higher in the ponds with aeration, corroborating the results of Pawar et al. (2009), who reported higher phytoplankton biomass in tanks with aeration due to nutrient availability, especially N-ammonia and N-nitrate.

The reduction in nutrients in the culture ponds' water occurs due to the absorption of inorganic forms of nitrogen and phosphorus by periphyton and phytoplankton (Bratvold & Browdy 2001; Asaduzzaman, Wahab, Verdegem, Huque, Salam & Azim 2008). The 50% reduction (i.e., 5.6–

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### Table 2 Mean values of limnological variable of ponds subjected to the effects of substrate and aeration

<table>
<thead>
<tr>
<th>Limnological variables</th>
<th>Substrate (S)</th>
<th>Aeration (A)</th>
<th>ANOVA P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(+)</td>
<td>(−)</td>
<td>(+)</td>
</tr>
<tr>
<td>Dissolved oxygen (mg L$^{-1}$)</td>
<td>4.6$^a$</td>
<td>6.3$^b$</td>
<td>7.2$^a$</td>
</tr>
<tr>
<td>Chlorophyll a (mg L$^{-1}$)</td>
<td>0.24$^a$</td>
<td>0.31$^b$</td>
<td>0.37$^a$</td>
</tr>
<tr>
<td>Turbidity (UNT)</td>
<td>57.1$^b$</td>
<td>66.9$^a$</td>
<td>70.6$^b$</td>
</tr>
<tr>
<td>Total suspended solids (mg L$^{-1}$)</td>
<td>49.1$^b$</td>
<td>58.7$^a$</td>
<td>67.2$^b$</td>
</tr>
<tr>
<td>N-ammonia (µg L$^{-1}$)</td>
<td>136.5</td>
<td>128.6</td>
<td>151.0$^b$</td>
</tr>
<tr>
<td>N-nitrate (µg L$^{-1}$)</td>
<td>16.4</td>
<td>16.3</td>
<td>17.3$^b$</td>
</tr>
<tr>
<td>N-nitrate (µg L$^{-1}$)</td>
<td>118.7$^a$</td>
<td>21.2$^b$</td>
<td>123.4$^a$</td>
</tr>
<tr>
<td>Total N-Kjeldahl (mg L$^{-1}$)</td>
<td>2.2</td>
<td>2.1</td>
<td>2.8$^a$</td>
</tr>
<tr>
<td>P-orthophosphate (µg L$^{-1}$)</td>
<td>2.8$^a$</td>
<td>5.6$^b$</td>
<td>5.4$^a$</td>
</tr>
<tr>
<td>Total phosphorus (µg L$^{-1}$)</td>
<td>22.3</td>
<td>20.2</td>
<td>22.7$^a$</td>
</tr>
</tbody>
</table>

(+)$^*$ presence; (−) absence. Different letters indicate significant differences among the effects within each factor (substrate and aeration). The means followed by different letters are significantly different (P < 0.05) in Tukey’s test.

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### Table 3 Mean values (± standard deviation) of total dry mass and total nitrogen (TN) and total phosphorus (TP) stock in the material adhering to the substrates

<table>
<thead>
<tr>
<th>Management system</th>
<th>Dry mass (g m$^{-2}$)</th>
<th>Stock (g m$^{-2}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TN</td>
<td>TP</td>
</tr>
<tr>
<td>SA</td>
<td>9547.7 ± 2069.5$^a$</td>
<td>3.81 ± 1.11</td>
</tr>
<tr>
<td>SWA</td>
<td>5179.7 ± 1358.1$^b$</td>
<td>3.52 ± 1.01</td>
</tr>
<tr>
<td>Nest -</td>
<td>0.038</td>
<td>0.74</td>
</tr>
<tr>
<td>P value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SA, with substrate and aeration; SWA, with substrate and without aeration.

Different letters indicate significant differences among the management systems. The means followed by different letters are significantly different (P < 0.05) in t-test.
2.8 mg L\(^{-1}\)) in P-orthophosphate concentration in the SWA treatment was probably due to the growth of periphyton. The substrate use in *M. rosenbergii* ponds culture (15 g m\(^{-2}\)) decreased 41.3% of the N-nitrate concentration (0.075–0.044 mg L\(^{-1}\)) and 32.1% of P-orthophosphate (1.87–1.27 mg L\(^{-1}\)) concentration in the pond water (Asaduzzaman et al. 2009). The N-nitrate concentration decreased in all treatments probably due to absorption of nitrogen and phosphorus by periphyton and phytoplankton. In the end of experiment, the N-nitrate concentration was higher in the SA treatment due to aeration, which moves water and favours the increasing of nutrients in the water column. The same result was not observed in the WSA treatment because the N-nitrate was absorbed by phytoplankton. It is confirmed by high chlorophyll \(\alpha\) concentration in the WSA treatment. The absorption of N and P increases the stock of these nutrients in periphyton.

The N stock in the periphyton was similar in SA and SWA treatments due to the absorption of inorganic forms, but the P stock was higher in the SA treatment than SWA probably due to sedimentation in the substrate of mineral particles suspended during the aeration. Phosphorus may be adsorbed to mineral particles, clays, carbonates and organic compounds in shallow aquatic ecosystems, especially those with oxidizing conditions and near-neutral pH values (Esteves & Panosso 2011). Under these conditions, the P (PO\(_4^{3-}\)) is easily adsorbed onto iron oxy-hydroxides, thus forming highly insoluble aggregates (e.g. FeOOHPO\(_4\)) (Wetzel 2001; Kalff 2002). The movement of the inorganic particles by aeration also increases the diffusion of oxygen into the sediment–water interface (Qin, Hu, Gao, Luo & Zhang 2004). It results in Fe and Al oxidation and the transformation of amorphous iron oxide into crystalline iron oxide, which adsorbs to P availability and turns it into an inert P form (Nguyen 2000; Li & Huang 2010).

The aerator operating between 02:00 and 05:00 hours kept the dissolved oxygen concentrations at higher levels, especially at the end of the farming period when the amounts of biomass and organic matter accumulated in the ponds were larger. In general, the reduction in dissolved oxygen in the pond water is related to the breathing of animals and the decomposition and mineralization of organic matter. These processes probably contributed to the reduction in oxygen concentration in all treatments. In the WSA and SA treatments, dissolved oxygen was high due to night-time aeration. The oxygen concentrations in the SWA and WSWA treatments were lower, but remained within the range considered optimal (between 3 and 7 mg L\(^{-1}\)) for *Macrobrachium* farming (Boyd & Zimmermann 2010). Despite the low values in the SWA and WSWA treatments, the dissolved oxygen concentration did not influence the prawn development, as the prawn production in these systems was similar to WSA and SA systems.

The increase in prawn biomass and the amount of food supplied contributed to the formation of detritus and the increase in the nutrients in the pond water. However, both biomass and the total quantity of food supplied in the non-aerated ponds (SWA and WSWA treatments) were similar to the quantity supplied in the aerated ponds (SA and WSA treatments). This fact suggests that the aerator is mainly responsible for the increase in seston and nutrients in the pond water.

The use of aerator increased oxygen concentrations, but we refute the hypothesis that aerator is necessary in the *M. amazonicum* semi-intensive farming stocked (45 prawns m\(^{-2}\)) in pond without water renewal because the concentration of dissolved oxygen in the ponds without aerator does not reach levels that are harmful to prawn development. In conclusion, the combination of substrate addition and night-time aeration use is not interesting because it does not favour prawn production and had a contrary effect on the water quality of ponds. The aerator lowered water quality because it increased the amount of detritus and nutrients in the pond water. We corroborate with the hypothesis that artificial substrate improves the pond water quality because it promotes periphyton growth and reduces the turbidity, chlorophyll \(\alpha\), TSS and P-orthophosphate concentrations. It may decrease the negative impact by the discharge of water in environment during harvest operation.

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