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Short communication

Pond-reared Malaysian prawn *Macrobrachium rosenbergii* with the biofloc system

J. Alberto Pérez-Fuentes, Carlos I. Pérez-Rostro *, Martha P. Hernández-Vergara

Laboratorio de mejoramiento genético y producción acuícola, Instituto Tecnológico de Boca del Río, Km. 12 Carr. Veracruz Córdoba, Boca del Río, Veracruz 94290, Mexico

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ABSTRACT

Physicochemical parameters of water and survival rate, growth, and body composition of the Malaysian prawn *Macrobrachium rosenbergii* were recorded and evaluated for six months in two nursery rearing systems: biofloc and traditional cultivation. The study was conducted in a shade house (300 m^{-3}, plastic mesh, 90% shade) in four rectangular ponds (20 m^{-3}). Stocking was at 37 prawns m^{-2} (0.025 g^{-1}) and fed twice daily with a commercial diet. Daily temperature, dissolved oxygen, pH, NH_3-N, NO_3-N, NO_2-N, and turbidity were recorded daily and the weight and length of the prawns were recorded each month. Water quality parameters were similar in both treatments, except transparency, which was significantly higher under traditional cultivation (36.10 ± 2.06 cm^{-1}) compared with the biofloc system (7.01 ± 1.52 cm^{-1}) at the end of the study. Survival rate was >85% under both treatments, but final size was significantly higher in the biofloc system (11.54 ± 1.87 g^{-1}, 15.18 ± 8.27 cm^{-1}) than in the traditional system (10.67 ± 2.26 g^{-1}, 12.57 ± 7.89 cm^{-1}). Protein (51.19%) and lipid (13.84%) content in harvested prawns was significantly higher in the biofloc system, which we ascribe to the nutritional contribution of complementary food. The results strongly suggest that the biofloc nursery system is a profitable alternative for locations where climatic and water restrictions do not allow traditional prawn cultivation and also contributes to sustainable use of water and improved nutritional quality of the prawns.

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1. Introduction

Aquaculture maintains steady growth as an alternative to open sea fisheries. Projections to 2030 indicate that aquaculture could produce 50% of the total production of seafood (FAO, 2004). A major challenge is to reduce water consumption required for maintaining quality and quantity of effluent and the amount of dissolved solids generated during production. Techniques to provide sustainable alternatives that would reduce environmental impact without affecting the health and growth of the crop organisms are essential. One option for the development of sustainable practices in aquaculture is biofloc technology.

The biofloc forms in pond water as the flocculent aggregates organic material, nitrogen-fixing bacteria, and algae in suspension, which serve as food for cultivated fish or crustaceans and promotes direct use of toxic metabolites by degrading the activity of the bacteria and algae (Avnimelech, 2007). The biofloc feed results from adding carbon sources to regulate the ratio of C:N that naturally varies between 15:1 and 20:1 (Asaduzzaman et al., 2008). The presence of bacteria in bioflocs has the advantage of decreasing concentrations of ammonium in the water, which, in turn, significantly improves the quality of the water for cultivation (Avnimelech and Lacher, 1999; Crab et al., 2007; Schryver et al., 2008). Biofloc technology has been successfully tested for shrimp (Burford et al., 2004) and to a lesser extent tilapia (Crab et al., 2009). Many aquaculture species can be grown efficiently in biofloc, including prawns, which are a detritivorous, opportunistic species that feeds on bacteria, fungi, and decomposing material (Milstein et al., 2001; Serfling, 2006). Among crustaceans that are economically important in aquaculture is the Malaysian prawn *Macrobrachium rosenbergii*, an omnivorous freshwater crustacean that consumes a wide variety of plants and animals, either living or decomposing, and also accepting balanced artificial diets. This prawn requires large areas and volumes of water, partly related to territoriality and competence; hence, cultivation in some countries has not achieved expected development, although the prawn adapts to many environments. Favorable production technology has been available for over 50 years. The grow-out of freshwater prawns is generally carried out in earthen ponds. These structures are usually cheap and simple to construct and operate, and with suitable management and simple inputs, allows for development of natural food, both planktonic and benthic microorganisms. Since semi-intensive culture is more expensive, there are more appropriate approaches for commercial farms (New and Singholka, 1984; New, 2002; Muir and Lombardi, 2010).

For intensive and semi-intensive prawn cultivation, traditional production of postlarvae (PL) is recommended with hatchery and nursery systems to maximize production efficiency in grow-out ponds. In nursery production, PL can be cultivated at much higher densities for the 1 to 3 months necessary for grow-out production (New, 2002). In temperate climates, nursery-raised PL are required

* Corresponding author. Tel./fax: +52 229 986 0189x113, 114.
E-mail address: ivandna02@hotmail.com (C.I. Pérez-Rostro).

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at the beginning of the outdoor season; therefore, production of juveniles occurs during the colder months of winter and early spring. At pond stocking, juveniles of the appropriate size and number must be available at the same time (Coyle et al., 2010).

Currently, there is little information on production of Malaysian prawns with biofloc technology, so it is difficult to establish the relevance of this technology and critical activities to improve production, however it is important to consider using this technique during nurseries because the presence of biofloc can significantly improve feed efficiency of prawn PL and quality during grow-out production. This study was intended to generate useful information for nursery-rearing and sustainability of prawn production by assessing the productivity and health of the Malaysian prawn with biofloc technology.

2. Materials and methods

Because the variation of temperature in winter in some areas bordering the Gulf of Mexico prevents farming of the Malaysian prawn, they remain in a nursery system in a shade house for six months (30 m × 10.5 m × 4.5 m high) covered with a cloth that reduced sunlight by 90%. The shade cloth reduced light intensity and provided moderation of temperature.

2.1. Experimental system

The experimental system consisted of four rectangular ponds (R1, R2, R3, and R4), covered with high-density polyethylene (1 mm thick). Each pond was 2 m × 10 m × 1.3 m deep. The water depth was 1.0 m; each pond contained 20 m^3 of water. Aeration was constantly supplied with a 2 HP blower connected to a PVC pipe (3.81 cm inside diameter), located on the bottom of the ponds.

The water came from an artesian well (10.16 cm diameter and 6 m deep) connected to a 2 HP pump through a PVC hydraulic line (5.08 cm inside diameter). Each pond contained four octagonal mud bricks with three holes (6 cm diameter, 10 cm long m^{-2}) per square meter as shelter (Jones and Ruscoe, 2001; Pineda, 2005) and to increase the two dimensional surface area within tanks, three squares (30 cm × 30 cm) of plastic netting were hung every 30 cm from parallel support lines above the water surface during cultivation (Ling, 1969; Valenti and Tidwell, 2006) (see Fig. 1).

2.2. Experimental design

A completely randomized design was used with two treatments (types of cultivation: biofloc, consisting of 3 replicates (R2, R3, and R4), and traditional cultivation, the control, with only one replicate (R1)). The lack of sufficient infrastructure made a division of one control pond to three treatment ponds preferable than two in each treatment. We used 2960 postlarvae (PL 5) at a stocking density of 740 per replicate (37 org m^{-2}). Average initial weight was 0.025 g and average initial length was 1.1 cm. The PL were purchased from a commercial hatchery.

Four days before stocking the PL, the ponds were filled to 30% capacity and fertilized with 900 mL liquid chelated fertilizer (Poliquel Multi, Biochemical Group Mexicano, Saltillo, Mexico) at a concentration of 3 mL per 20 L of water to stimulate primary production and zooplankton (Morlarty and Pullin, 1987). Every day, 1.96 g of molasses, at a C:N ratio of 20:1 for promoting bioflocculation and bacterial growth, was added to the three experimental ponds. Asaduzzaman et al. (2008) state that feed protein contains 16% N and 70% of the nitrogen intake is excreted as ammonium. If the prawns consume 1 kg of feed with 35% protein, containing 16% nitrogen, then, the amount of nitrogen consumed by a prawn is 56 g and the amount of nitrogen excreted by the prawns is ~39.2 g. If the molasses has a C:N ratio of 20:1, 1 g of nitrogen required 20 g of carbon; hence, 39.2 g of nitrogen required 784 g of carbon. Sierra-De La Rosa (2009) states that molasses contains 40% carbon, so if 784 g C is equal to 40%, then 100% will be 1960 g molasses.

During cultivation, the prawns in the treatment ponds and the control pond were fed twice daily (09:00 and 16:00 h) with a commercial shrimp diet (Silver Cup, Group El Pedregal Silver Cup®, Toluca, Mexico) containing 35% protein. The food was distributed around the perimeter and the central area in the ponds to reduce the bull effect. The food level was adjusted monthly, based on growth after the initial biomass of prawns during the first month of cultivation.

2.3. Physicochemical variables in water

Dissolved oxygen (DO; mg/L), temperature (°C), and pH of the water of the two treatments were recorded daily at 21:00 (YSI556 MPS multi-probe, YSI, Yellow Springs, OH). Each week, transparency

Fig. 1. Biofloc system experimental pond to cultivate Malaysian prawns.

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