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Title: **Effects of addition of red tilapia (*Oreochromis* spp.) at different densities and sizes on production, water quality and nutrient recovery of intensive culture of white shrimp (*Litopenaeus vannamei*) in cement tanks**

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Abstract: An experiment was conducted in 21 outdoor cement tanks (2.5x2x1.2 m) from 8 December 2005 to 3 March 2006 to determine the effects of adding red tilapia (*Oreochromis* spp.) at different densities and sizes on production, water quality and nutrient recovery in intensive culture tanks of white shrimp (*Litopenaeus vannamei*). Shrimp postlarvae of 0.06 g were stocked into all tanks at a density of 60 postlarvae m^{-2}, while either small (13.8±0.2 g) or large (41.9±0.3 g) mono-sex tilapia fingerlings were stocked into the shrimp tanks two weeks later at low (0.4 fish m^{-2}), medium (0.8 fish m^{-2}) or high (1.2 fish m^{-2}) density. Water depth in all tanks was maintained at 1 m and salinity at 20 ppt. Water loss due to evaporation was compensated weekly. The experiment was conducted in a 2x3 factorial design, while three additional tanks for shrimp monoculture were set as a control. All treatments and the control were randomly allocated to tanks in triplicate each. Shrimps were fed three times daily with commercial pellets using feeding trays made with metal frame and nylon mesh (0.6x0.6x0.05 m) at the same feeding rates as those for the control. No separate feed was given to tilapia.

The highest shrimp survival rate of 66.8% was obtained in the small–low density tilapia treatment, which was significantly higher than those in other treatments and the control. The small-low density tilapia treatment had the highest shrimp yield and lowest feed conversion ratio, which was similar to those in the control and the large-low and small-medium

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density tilapia treatments, but significantly better than those in other treatments. Factorial analyses revealed that the increase of tilapia density from 0.4 to 1.2 fish m^{-2} and size from 13.8 to 41.9 g negatively affected shrimp production performance but remarkably increased the combined production of shrimp and tilapia. Polyculture incorporated 36.0-49.5% of the total nitrogen input and 14.2-26.5% of the total phosphorous input into shrimp and tilapia, which were significantly higher than those (27.1% and 8.9%) in the monoculture, respectively. The nutrient recovery efficiency increased with increased tilapia stocking size and density. Polyculture with small tilapia stocked at low density had the best economic performance among all treatments and control, and significantly better than small-high, large-medium and large-high density tilapia treatments.

It was concluded that addition of red tilapia at suitable stocking densities and sizes into intensive white shrimp monoculture can improve productivity, profitability, nutrient utilization and environmental friendliness of shrimp monoculture. The suitable stocking density and size of red tilapia identified in this study were 0.4 fish m^{-2} and 13.7 g respectively. Red tilapia could be stocked at higher density and larger size up to 1.2 fish m^{-2} and 42 g respectively to maximize system productivity and minimize nutrient waste without affecting shrimp survival, but economic performance could be negatively affected. Shrimp–tilapia polyculture should be promoted to improve sustainability of shrimp culture.

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