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Protein levels for *Litopenaeus vannamei* in semi-intensive and biofloc systems

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ABSTRACT

The aims of this research were to evaluate the zootechnical performance and dietary cost for the marine shrimp (*Litopenaeus vannamei*) cultured in a superintensive biofloc system and a conventional semi-intensive system using diets containing different protein levels. Four different diets, with crude protein (CP) contents of 24.3, 30.3, 32.9 and 36.7% were produced. In the laboratory, experimental culture in the biofloc system was performed in twelve experimental units at a density of 250 shrimp m^{-3}, the four treatments were performed in triplicate. The semi-intensive culture system was applied at the commercial farm in eleven ponds containing 15.5 shrimp m^{-2}. After 49 days, the zootechnical performance of the shrimp was rated, and the cost per kilogram of shrimp was produced by both culture systems. In the semi-intensive system, the shrimp fed with a diet containing 32.9% CP showed a higher final weight and weight gain and a lower dietary cost. In the biofloc culture, a higher final weight, weight gain, growth rate and productivity were observed in shrimp fed diets containing 30.3, 32.9 and 36.7% CP compared with those fed a diet containing 24.3% CP. The lowest dietary cost of shrimp farming in the biofloc system was registered in the shrimp fed the 30.3% CP diet, whereas, in the semi-intensive system, the highest final weight, highest weight gain and lowest cost were observed in shrimp fed the 32.9% CP diet.

1. Introduction

Shrimp nutrition is extremely important to make a shrimp farm profitable because the cost of the diet exceeds 50% of the variable production cost of a commercial enterprise. Among the macronutrients present in the diet, protein is the most important due not only to its high demand but also its high cost. *Litopenaeus vannamei* requires 30–44% crude protein (CP) in its diet, depending on its stage of life (Cuzon et al., 2004; Rosas et al., 2001; Tacon and Metian, 2008). In the commercial culture phase (3 to 16 g), the requirement is 30% digestible protein (National Research Council, NRC, 2001), and this nutrient is the most expensive component of the diet.

Thus, appropriate concentrations of protein must be included, avoiding both excesses and deficiencies of this nutrient, which could harm the animals' growth and contribute to the eutrophication of ponds and adjacent environments. However, the use of this macronutrient can potentially be affected by various biotic and abiotic factors, including the culture system (Akiyama et al., 1992; Cuzon et al., 2004; Lawrence and Lee, 1997; Sarac et al., 1993). Thus, understanding the effect of the amount of protein provided in different culture systems is necessary.

In conventional systems and semi-intensive ponds, natural food can supply up to 70% of the nutritional requirements of shrimp, benthic organisms and zooplankton constituting the essential components of this food source (Martinez-Cordova et al., 2003). In biofloc culture systems, the "natural food" consists of diatoms, macroalgae, food and faecal remnants, exoskeletons, bacteria and invertebrates. These food items form an aggregate of living and dead organic matter suspended in water (Avnimelech, 1999, 2006; Burford et al., 2003; Hargreaves, 2006; McIntosh, 2000; Michaud et al., 2006; Taw, 2010; Wasielesky et al., 2006). Hence, the availability of this natural food allows the amount of protein in the diet and its cost to be reduced.

A number of nutritional studies have been conducted on the use of various alternative ingredients in shrimp farming, particularly with the aim of reducing or replacing the use of fishmeal in biofloc culture systems (Amaya et al., 2007; Bauer et al., 2012; Browdy et al., 2006;

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