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Taurine supplementation to alternative dietary proteins used in fish meal replacement enhances growth of juvenile cobia (*Rachycentron canadum*)

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Abstract

Two separate 8 week feeding trials were conducted to examine the impacts of fish meal replacement with an organically certifiable yeast-based protein source with and without supplementation of methionine, tryptophan, and taurine to diets for juvenile cobia. In the first trial, diets were formulated to contain 41% crude protein and 13% lipid, and a yeast-based protein replaced fish meal at 50 and 75% of dietary protein with and without supplemental taurine at 0.5 g/100 g dry diet. The control diet contained 100% herring fish meal. Methionine and tryptophan were added to all diets except the control to resemble the amino acid profile of fish meal. Results from this study indicated that fish fed diets supplemented with taurine exhibited significantly higher weight gain and better feed efficiencies than all other fish. Diet significantly impacted biological indices such as muscle ratio (MR), visceral somatic index (VSI), and hepatosomatic index (HSI). The 75% yeast-based protein diet without taurine returned the lowest MR values and the highest VSI and HSI values. In the second trial, diets were formulated to contain 43% crude protein and 11% lipid, with the control diet containing 100% herring fish meal and the same yeast-based protein replacing fish meal at 50, 75, and 100% of dietary protein. All diets except the control were supplemented with taurine at 0.5 g/100 g dry diet. Results from this study indicated that increasing amount of yeast-based protein led to decreased weight gains and feed efficiencies regardless of taurine supplementation. However, weight gain and feed efficiencies did increase when compared to a previous study [Lunger, A.N., McLean, E., Craig, S.R., 2007. The effects of organic protein supplementation upon growth, feed conversion and texture quality parameters in juvenile cobia (*Rachycentron canadum*). Aquaculture 264, 342–352] using identical diet formulations except for taurine supplementation. MR values tended to decrease while VSI and HSI values tended to increase with increasing fish meal replacement. It is obvious from the results from both of the present studies that taurine supplementation does have a significant impact on growth and feed efficiency of juvenile cobia when they are fed diets containing high levels of plant-based proteins as

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replacements for fish meal. Additionally, alternate proteins, especially those of plant and yeast-based origin can be incorporated at very high levels in diets for cobia with proper amino acid supplementation.

Keywords: Amino acid; Alternate proteins; Yeast; Quality; Fish meal replacement

1. Introduction

In aquaculture production, fish meal is typically regarded as the main protein source in diets for carnivorous fish due to its high level of protein, excellent amino acid profile which provides adequate levels of all essential amino acids, low carbohydrate level, high digestibility, and few antinutritional factors (Zhou et al., 2004). As aquaculture production continues to increase, so too has the industry's demand for fish meal. However, due to the stagnant supply of fish meal, prices will inevitably increase with demand (FAO, 2004; Lunger et al., 2007). This has amplified the need to investigate alternative protein sources. The use of plant proteins in diets for carnivorous species creates a challenge since they typically require higher levels of protein in their diet and plant proteins are less palatable. Nevertheless, several studies have shown promising results using plant-based protein sources in aquafeed formulations (Gomes et al., 1995; McGoogan and Gatlin, 1997; Fagbenro and Davies, 2001; Tidwell and Allan, 2001; Forster, 2002; Pereira and Oliva-Teles, 2003; Chou et al., 2004). Plant protein sources that have received the most interest are soybean meal and corn gluten meal due to their good amino acid profiles except for methionine which is limiting in soybean meal (El-Sayed, 1999), and lysine which is limiting in corn gluten mean (Pereira and Oliva-Teles, 2003).

Total replacement of fish meal and soybean meal with an organically certifiable yeast-based protein has been reported in diets for tilapia without impacting weight gain (Craig and McLean, 2005). In a previous study using cobia, a carnivorous species, the same yeast-based protein was able to replace 25% of the fish meal protein without impacting growth parameters (Lunger et al., 2006). Further dietary inclusion rates for this protein might be problematic however due to amino acid imbalances (Craig and McLean, 2006).

Methionine is an essential amino acid required by fish for normal growth and metabolic functions (NRC, 1993; Luo et al., 2005). Since many plant proteins are deficient in methionine, it is typically the first limiting amino acid in diets which replace fish meal with large amounts of plant protein. Methionine deficiencies result in reduced growth rates, feed efficiency and survival (Goff and Gatlin, 2004) such that in diets containing high levels of plant proteins, methionine supplementation must be utilized so that growth is not compromised (Jackson and Capper, 1982, Murai et al., 1982, Takagi et al., 2001).

Taurine is not considered to be an essential amino acid because it can be synthesized by fish. As in mammals, Yokoyama et al. (1997) demonstrated that rainbow trout synthesized taurine from cysteine. In the mammalian system, taurine is synthesized through many enzymatic reactions; but the enzyme L-cysteine-sulphinate decarboxylase appears to be rate-limiting (Jacobsen and Smith, 1968). Activity of this enzyme varies in fish depending upon species and size. For example, in the yellowtail, as well in bluefin and skipjack tunas, L-cysteinesulphinate decarboxylase activity is not present, whereas in Japanese flounder it expresses only low activity (Yokoyama et al., 2001).

Taurine is typically found in relatively high concentrations in fish meal and animal by-products but is almost non-existent in plant meals. Even when all essential amino acid requirements are met in plant-based diets for carnivorous fish, growth still is often reduced when compared to fish meal-based diets (Gaylord et al., 2006). Therefore, taurine supplementation may be required for plant-based diets and indeed, dietary taurine additions improve weight gain and feed efficiency in olive flounder (Park et al., 2002; Kim et al., 2005a), as well as in rainbow trout (Gaylord et al., 2006). Based on this information, the current studies were undertaken to examine whether higher levels of fish meal could be replaced in cobia diets utilizing yeast-based proteins and specific amino acid supplementation including methionine, tryptophan and taurine.

2. Materials and methods

2.1. Experiment 1

2.1.1. Experimental system and husbandry

All studies were undertaken using a recirculating aquaculture system. The 3400 l recirculation configuration (flow rate = 4 l/min-aquaria) was comprised of 24,