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Juvenile cobia (*Rachycentron canadum*) can utilize a wide range of protein and lipid levels without impacts on production characteristics

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Abstract

Two, 6 week feeding trials were conducted to evaluate the impacts of protein and lipid on weight gain, feed efficiency ratio values and biological indices of juvenile cobia (*Rachycentron canadum*). Utilizing a 2×3 factorial design, experimental diets containing two levels of crude protein (CP; 40 and 50%) and three levels of lipid (6, 12 and 18%), providing 14.4, 15.1 and 16.6 kJ available energy/g dry diet (calculated), respectively, were formulated for use in both feeding trials. In the first trial, cobia (initial weight 49.3 g per fish) was randomly assigned to one of the six experimental diets and fed to apparent satiation twice daily. At the end of the first trial, weight gain in cobia was not significantly impacted by protein levels with values ranging from 333% (50% CP) to 353% (40% CP). However, lipid significantly ($P<0.05$) affected weight gain with fish fed the diet containing 18% total lipid returning the lowest growth of 293%. Feed efficiency ratio values were not significantly impacted by dietary protein or lipid levels and ranged from 0.46 (50% CP/18% lipid) to 0.51 (50% CP/6 and 12% lipid). Survival was significantly impacted by protein and lipid with fish fed the diets containing 50% CP and 18% lipid having lower ($P<0.05$) survival rates of 90%.

In the second trial, smaller fish were utilized (7.4 g average initial weight) under identical experimental conditions and dietary formulations. Weight gain was not significantly affected by protein or lipid levels and ranged from 1099% in fish fed the diet containing 40% CP/18% lipid to 1305% in fish fed the diet containing 50% CP/12% lipid. Feed efficiency ratio values, visceral somatic and hepatosomatic indices were significantly affected by protein and/or lipid. Muscle and liver lipid were impacted by dietary lipid ($P=0.0203$ and 0.0012, respectively). Muscle protein was significantly impacted by dietary protein levels, while liver protein was affected by both main effects. Dietary protein and lipid had no impact on muscle ash.

These data suggest that juvenile cobia can thrive on a wide range of protein and lipid levels, as well as a range of protein to energy ratios. Positive impacts of optimizing the protein component in terms of economic and environmental concerns, coupled with the ability to maintain the rapid growth rates this species are renowned for at lower dietary lipid levels, point towards beneficial consequences of further refinement of commercial cobia production feeds.

Keywords: Cobia; Protein; Energy; Lipid; Health

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1. Introduction

Cobia represents a species of increasing interest to aquaculture due to its impressive growth performance (Chou et al., 2001; Lunger et al., 2006). This species also expresses many other favorable production-related characteristics which include spawning in captivity (Caylor et al., 1994; Arnold et al., 2002; Faulk and Holt, 2006), high survival post-weaning (Kaiser and Holt, in press), ability to withstand shifts in salinity (Faulk and Holt, 2006) and responsiveness to vaccination (Lin et al., 2006). Cobias also adapt to confinement and readily accept commercially-available extruded diets (Craig and McLean, 2005). Importantly, this species produces a high quality fillet suitable for the sashimi and white table cloth restaurant businesses which presently enhances their market value. However, while a fledgling cobia aquaculture industry already exists; future expansion that capitalizes on the true potential of this species will be heavily dependent upon increasing our general knowledge of its basic nutritional and environmental requirements.

Quantitative nutritional requirements for a species with such intense global interest are severely lacking. While optimal protein and lipid levels have been determined (Chou et al., 2001) and a few investigations involving utilization of alternate protein sources in the species (Chou et al., 2005; Lunger et al., 2006) and impacts of dietary lipid (Wang et al., 2005) have been conducted, very little information is available as to the specific nutrient requirements of cobia. Indeed, currently there is no information for specific requirements of cobia for any of the essential amino acids, essential fatty acids or other key nutrients so necessary for the successful and economically viable culture of cobia on a commercial level.

As protein represents the most expensive component of aquafeeds (Cho et al., 2005; Craig and McLean, 2005; Miller et al., 2005), from an economic standpoint it is vitally important that protein be utilized for the synthesis of muscle tissue and not for metabolic energy (Williams et al., 2003; Ozorio et al., 2006). Protein sparing by non-protein energy sources has been documented in a wide range of species (Serrano et al., 1992; Shiau and Peng, 1993; Thoman et al., 1999; Azevedo et al., 2002), but protein sparing by lipid has been best documented in the salmonids (Einen and Roem, 1997; Refstie et al., 2001; Azevedo et al., 2002). The ability to utilize lipid rather than protein as an energy source can lead to a decreased loss of ingested protein by catabolism (Refstie et al., 2001; Williams et al., 2003), thereby potentially reducing nitrogenous waste input into culture systems (Miller et al., 2005). This could have dramatic impacts on environmentally sensitive receiving waters or effluents from high density recirculating aquaculture systems (RAS).

It has been well established that protein to energy ratios in aquafeeds have significant impacts on fish performance (Nematipour et al., 1992; Lee et al., 2000; Azevedo et al., 2002; Cho et al., 2005). Fish feed to satisfy their energy requirements, and if dietary energy is insufficient, i.e. a high protein to energy ratio, feed consumption is increased (Mathis et al., 2003) and dietary protein will be utilized for metabolic energy, not only resulting in an inefficient use of an expensive dietary component, but also contributing to nitrogenous wastes in effluent waters. As well, if dietary energy is too high, i.e. a low protein to energy ratio, feed consumption is reduced, and as a result, fish will reduce feeding with resultant growth reduction due to an intake reduction of other essential nutrients (Cho et al., 2005). Additionally, excessive dietary energy can result in increased lipid deposition (Nematipour et al., 1992) that can negatively impact the health and well being of the cultured animal (Craig et al., 1999). Clearly, accurate protein to energy ratio values are necessary to optimize dietary formulations for any cultured species. This is particularly so for rapidly growing animals such as cobia, not only from an economic standpoint of cost-effective diet formulations, but also from a final product quality perspective.

The present study was undertaken to investigate the impacts of varying protein and lipid levels, and thus, protein to energy ratios, on weight gain, feed efficiency ratio values and other production characteristics of juvenile cobia. Two separate feeding trials involving identical diets and RAS were conducted to further our understanding of protein to energy ratios and optimal protein and lipid levels in dietary formulations for cobia.

2. Materials and methods

Feeding trials were conducted at the Virginia Seafood Agricultural Research and Extension Center (VSAREC) in Hampton, VA, and the Virginia Tech Aquaculture Center (VTAC) in Blacksburg, VA in identically constructed and operated RAS. The RAS incorporated 24, 110 l glass aquaria connected to a KMT-based (Kaldnes Inc, Providence, RI) fluidized-bed biofilter for conversion of ammonia to nitrate, a bubble bead filter (Aquaculture Technologies Inc., Metaire, LA) was used to eliminate solids (uneaten feed, fecal material, mucus and other fish waste), a protein skimmer (R and B Aquatic Distribution, Waring, TX) for removal of ultra-fine particulates and dissolved materials, and a 40 W UV sterilizer (Emperor Aquatics, Pottstown, PA) for disinfection. The aquaria and sump water were oxygenated using diffusion air lines