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Evaluation of poultry by-product meal in commercial diets for hybrid striped bass (*Morone chrysops* ♀ × *M. saxatilis* ♂) in recirculated tank production

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Abstract

The efficacy of replacing fishmeal with petfood-grade poultry by-product (PBM) on an ideal protein basis in commercial diets for hybrid striped bass (HSB) was evaluated under production conditions in tank culture. A generic production diet (GEN) for HSB was formulated to contain 45% protein, 12% lipid and 3.7 kcal/kg. Protein in the generic diet was supplied by a mix of animal and plant sources typically used by the industry that included more than 20% select menhaden fishmeal and less than 10% PBM. A positive control diet (GEN+AA) was formulated by supplementing the generic diet with feed-grade Met and Lys to match the level of those amino acids in HSB muscle at 40% digestible protein. Substitution diets were formulated by replacing 35% or 70% of fishmeal in the GEN diet with PBM on a digestible protein basis and then supplementing with Met and Lys (designated 35PBM and 70PBM, respectively) as needed to maintain concentrations of Met and Lys equal to those in the GEN+AA diet. Diet formulation and extrusion were conducted by a commercial mill. Fish were stocked (87 g average initial weight) in three replicated production-scale recirculating culture systems. Diets were initially fed at 4% body weight·day^{-1} divided into morning and evening feedings and gradually decreased to 1.5% body weight·day^{-1} during the 24-week trial. The availability of indispensable amino acids (IAA) in the commercial test diets were determined in a separate trial. All test diets were replete with respect to published requirements of hybrid striped bass; however, available levels of Arg and Thr were first- and second-limiting, respectively, and His was third-limiting, in the replacement diets when compared to the IAA profile of hybrid striped bass muscle.

Diet composition significantly ($P<0.05$) influenced final weight, weight gain, yield, hepatosomatic index (HSI) and intraperitoneal fat (IPF) ratio, but did not significantly alter feed conversion and muscle ratio. Generally, fish fed the 35% replacement diet (35PBM) performed as well as fish fed the generic diet, whereas fish fed the 70PBM diet not. Fish fed the supplemented generic diet (GEN+AA) outperformed fish fed the other test diets. Results clearly demonstrate that formulation on an available amino acid basis can significantly improve the performance of current diets for HSB and that petfood-grade poultry by-product can successfully provide nearly half the protein in commercial HSB diets when substituted for fishmeal on an available amino acid basis.

Keywords: Hybrid striped bass; Nutrition; Poultry by-product; Fish meal replacement; Ideal protein

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1. Introduction

Data regarding amino acid availability in feedstuffs for hybrid striped bass now make it possible to formulate diets on an amino acid availability, rather than gross nutrient digestibility, basis (Gaylord et al., 2004). By-products of the poultry processing industry such as blood meal, feather meal and poultry by-product meal (PBM) are high in protein and contain favorable profiles of indispensable amino acids (IAA) for fish production (Tacon, 1993). Commercial diets for hybrid striped bass already contain some PBM in place of fishmeal; however, inclusion rates are limited to avoid the negative effects observed in other fish when higher inclusion levels have been attempted (David Burris, Burris Aquaculture and Specialty Feeds, Franklinton, LA, USA, personal communication).

One limitation to incorporating substantial levels of PBM in carnivorous fish diets proceeds from factors related to product source and processing. It is well established that source and processing conditions can radically affect specific amino acid availability in rendered products (Parsons et al., 1997; Johnson et al., 1998; Wang and Parsons, 1998). Nengas et al. (1999) found that locally available PBM caused severe growth depression in red sea bream whereas a superior grade of PBM caused only slight reductions in growth. Bureau et al. (1999) observed high variation in both quality and digestibility of a variety of poultry products in rainbow trout due to processing method. Dong et al. (1993) noted significant differences in chemical composition as well as protein digestibility of PBM in salmonids depending on the product source. Another limitation proceeds from factors associated with diet formulation. Attention to the levels and final ratios of IAA in the diet is often lacking after fishmeal has been totally or partially replaced and are underlying reasons that PBM-based diets fail to perform like fishmeal-based control diets (Abdel-Warith et al., 2001; Millamena and Golez, 2001; Emre et al., 2003; Turker et al., 2005).

Two possible strategies to circumvent these limitations are use of higher quality by-products and modification of the upper bounds of least-cost formulas with regard to amino acid supplementation. Due to added controls during offal collection and processing, petfood-grade PBM is a high quality, low-ash by-product of more uniform composition than its FAQ (fair and average quality) counterpart (Miller, 1996). Bureau et al. (1999) noted significant improvements in the digestibility of nutrients in PBM as compared to earlier work (Cho and Slinger, 1979). Secondly, results of comparative fishmeal replacement studies in trout and turbot suggest that formulating to the putative amino acid requirements of a species of interest is insufficient (Fournier et al., 2003, 2004). Livestock diets are often formulated on an ideal protein basis, i.e. formulated to meet an "ideal" amino acid profile based on the pattern found in a generally accepted tissue model (Fuller et al., 1979). Mambrini and Kaushik (1995) suggested that the amino acid profile of fish meal might be a suitable model for fish and that formulating on this basis would necessitate supplementation of IAA above published requirement estimates. Indeed, Twibell et al. (2003) demonstrated that increasing the dietary IAA content to match the amino acid profile of herring meal improved the growth of hybrid striped bass above that observed for fish fed a diet formulated to meet the IAA requirements.

We recently demonstrated that petfood-grade PBM effectively replaced 100% of fishmeal in semi-purified diets for hybrid striped bass when substituted on an ideal protein basis (Gaylord and Rawles, 2005). In that study, Met and Lys supplementation of a diet in which all protein was provided by PBM ameliorated deficiencies in hybrid striped bass production when fish were fed the unsupplemented PBM diet. Moreover, fish fed the supplemented PBM diet exhibited equivalent weight gain and feed efficiency as fish fed a diet in which all protein was supplied by fishmeal. The purpose of this study was to address the efficacy of commercial fishmeal replacement diets for hybrid striped bass that are formulated using a similar strategy.

2. Materials and methods

2.1. Commercial test diets

A generic commercial production diet (GEN) for hybrid striped bass was formulated to contain 45% protein, 12% lipid and 3.7 kcal/kg estimated available energy (Table 1). Protein in the GEN diet was supplied by a mix of animal and plant sources (Burris Aquaculture and Specialty Feeds, Franklinton, LA) that included more than 20% select menhaden fishmeal (MFM) and less than 10% PBM, and are considered typical of commercial formulations. Digestible protein and available Met and Lys in the GEN diet from MFM and PBM were estimated from the data of Gaylord and Rawles (2005). Since the availability of IAA to *Morone* spp. had not been determined for the remaining dietary protein sources, gross Met and Lys levels expected in the remaining ingredients (NRC, 1993) were added to available Met and Lys from MFM and PBM in order to approximate total levels of these amino acids in the GEN formula.