RAPID DETERMINATION OF AMINO ACID REQUIREMENTS OF YELLOW PERCH AND TILAPIA[8]

Project ***Termination Report*** for the Period September 1, 2009 to August 31, 2011

NCRAC FUNDING: $80,000 (September 1, 2009 to August 31, 2011)

PARTICIPANTS:

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REASON FOR TERMINATION

The objectives have been completed and the funds terminated.

PROJECT OBJECTIVES

(1) Conduct a full literature search on amino acid composition, amino acid requirements, and feed formulations for yellow perch and Nile tilapia.
(2) Evaluate body amino acid composition of yellow perch and Nile tilapia.
(3) Evaluate limiting amino acid requirements of yellow perch and Nile tilapia.
(4) Evaluate amino acid availability of dietary ingredients for yellow perch and Nile tilapia.
(5) Develop a least-cost formulation model available to the NCR aquaculture industry within a two-year period for yellow perch and Nile tilapia.
(6) Coordinate findings from this study with the Technical Committee Extension Subcommittee of NCRAC.

[8]NCRAC has funded three Nutrition/Diets projects. The Termination Report for the first project is contained in the 1997-98 Annual Progress Report. The Termination Report for the second Nutrition/Diets project is contained in the 2008-09 Annual Progress Report. This Progress Report is for the third project. It is a 2-year project that began September 1, 2009.

PRINCIPAL ACCOMPLISHMENTS

OBJECTIVE 1
Literature searches have been conducted on feedstuffs' amino acid composition, amino acid requirements, and feed formulations for grow-out-stage yellow perch and Nile tilapia. Although trout diets are practical diets that are often used by yellow perch producers, these diets may not be appropriate for that species. For instance, the lipid requirement for yellow perch is 6-8%, compared to diets that typically contain, 16- 17% lipid. Feeding trout diets to yellow perch may promote substantial fat deposition. Excess fat deposition not only reduces fillet yield, but also decreases feed consumption and ultimately, fish production. Moreover, the costs of trout diets threaten the economic sustainability of yellow perch farming.

OBJECTIVE 2
A study was conducted to model dietary essential amino acid requirement for yellow perch, based on digestible dietary lysine requirement (1.25%) and whole-body amino acids profile. Eighteen wild-cultured juvenile yellow perch (22±1.3 g) were fasted for 24 h and then euthanatized, ground and stored for analysis. Six fish were grouped as one sample, with three samples being used to determine the EAA profile of whole-body tissue. The modeled essential amino acids requirement was similar to that determined by the dose-response approach which, when expressed relative to the lysine A/E ratio, was estimated to be: Arginine 1.07%, methionine 0.44%, leucine 1.11%,
isoleucine 0.61%, valine 0.7%, Phenylalanine 0.6%, trptophan 0.48%, histidine 0.36%, and threonine 0.65%.

The tilapia lysine experiment for grow-out- size male tilapia was not completed even though researchers attempted this project twice in 2010 and 2012, respectively. Grow- out-size male tilapia exhibited strong social hierarchies, wherein the larger fish continued to chase and bite the relatively small individuals, until they perished. Mortality reached 80% in first experiment, which ran until 2010. In the second effort, researchers used various barriers and stones to reduce the internal conflict and increase fish density; however, mortality remained up to 70% after a 6-week experimental period. It was this difficulty that also prevented the completion of objectives 3-5 for tilapia, and hence, only information related to yellow perch will be presented.

OBJECTIVE 3
A study was also conducted to determine the dietary lysine requirement of yellow perch in an indoor, water flow-through system. Six isonitrogenous and isoenergetic experimental diets were formulated to contain graded levels of lysine (1.1, 1.3, 1.5, 1.7, 1.9, 2.2) from commercial ingredients and crystalline lysine. Crystalline, methionine, and arginine were supplemented in all experimental diets, to satisfy requirements according to previous work on yellow perch. Results showed that relative growth rate (RGR), feed conversion ratio (FCR), protein efficiency ratio (PER) and protein retention (PR), significantly increased with increasing dietary lysine level, from 1.1 to 1.5% of the diet, and then leveled off. Whole-body crude protein (14.48–15.9%), as well as lysine (1.15- 1.22%), increased significantly with increasing dietary lysine level ($P<0.05$), whereas moisture, fat and ash, showed no significant differences among the dietary treatments. The lysine requirement of yellow perch was estimated as 1.33% of dry diet and 1.25% at the digestible level based on growth performance.

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OBJECTIVE 4
The digestibility study for grow-out-stage Nile tilapia has been completed. Nine common feedstuffs including fish meal, poultry byproduct meal, meat and bone meal, blood meal, soybean meal, peanut meal, corn gluten meal, as well as wheat and corn, have been tested in this experiment. Digestible energy, protein and amino acids have been evaluated. These data will be important mainly for the ideal protein diet formulation and least-cost diet formulation.

Apparent digestibility of dry matter, energy, and amino acids in fish meal, meat and bone meal, poultry byproduct meal, soybean meal, corn gluten meal and wheat, were determined for yellow perch (body weight, 19.7±1.5 g) by using single test ingredients. Apparent dry matter digestibility ranged from 58% (meat and bone meal) to 79% (fish meal) for animal products and from 47% (wheat) to 72% (corn gluten meal) for plant products. Apparent energy digestibility values ranged from 52% (wheat) to 88% (fish meal) for yellow perch. Apparent digestibility of crude protein for animal products and plant products ranged from 85%-88% and 82%-90%, respectively. Apparent digestibilities of most essential amino acids exceeded 90% except for meat and bone meal, and corn gluten meal. These data provide more precise information on nutrient and energy availability for yellow perch, and hence, should enable aquaculture nutritionists to design yellow perch formulae based upon digestible nutrients.

OBJECTIVE 5
A study was conducted to determine the feasibility of replacing fish meal with poultry byproduct meal in yellow perch, in an indoor re-circulating system. Five experimental diets were formulated with poultry byproduct meal replacing 0, 25, 50, 75, and 100% of the fish meal protein (PBM0 control), PBM25, PBM50, PBM75, and PBM100, respectively; all diets were compared against a commercial diet (Aquamax grower 400 [minimum 45% of crude protein]; Purina Mills). Experimental diets were formulated to contain required digestible requirement values of 33-34% crude protein, and 3,420 kcal/kg of digestible energy for yellow perch. Crystalline methionine and lysine were supplemented in all experimental diets to satisfy the dietary requirements according to previous research on yellow perch.

Results indicated that fish fed with PBM75 and PBM100 showed a significantly lower specific growth rate (SGR) and weight gain (WG) than fish fed PBM0 ($P<0.05$) or the commercial diet. Fish fed PBM100 showed a significantly lower feed intake (FI), feed efficiency (FE) and protein efficiency ratio (PER), than fish fed with PMB0 ($P<0.05$). Whole body protein and lipid contents declined linearly with increasing inclusion of PBM, and there was no significant difference in whole body moisture content shown in this study. There were no significant differences in survival rates among the experimental treatments.

In conclusion, yellow perch appear capable of using high quality poultry byproduct meal at high inclusion levels. PBM is able to replace 50% of fish meal protein without impeding growth performance. Moreover, replacement could be as high as 75% without reducing FE and PER.

OBJECTIVE 6
The least-cost formulation will be presented to the NCRAC community for later field testing.

IMPACTS

- A cost-effective diet for yellow perch has been developed for future analyses as a diet for fish cultured under commercial conditions. Yellow perch appear capable of using high-quality poultry byproduct meal (PBM) at high inclusion levels. PBM is able to replace as much as 50% of fish meal protein without impairing growth performance. In addition, replacement could be up to 75% without reducing feed efficiency and protein efficiency ratio.

RECOMMENDED FOLLOW-UP ACTIVITIES
The identification of a new, cost-effective diet for yellow perch through laboratory studies, still warrants testing under field conditions with production scales used by regional producers. It is anticipated that these fish reared in ponds will not only feed on the provided diets, but also on natural feed stuffs including aquatic invertebrates. The combination of a commercial diet with these natural feedstuffs may result in different production parameters.

PUBLICATIONS, MANUSCRIPTS, OR PAPERS PRESENTED
See the Appendix for a cumulative output for all NCRAC-funded Nutrition activities.