

United Soybean Board
Final Report Form – Technical Bulletin

Project # and Title	RFP 2463 - A Study on the Benefits of Using High Soy Feed Formulations Supplemented with Taurine in US Marine Feeds
Organization & Project Leader	Auburn University, Department of Fisheries and Allied Aquacultures Primary Investigators: Drs. Terry Hanson, D. Allen Davis and Jesse Chappell, AU Department of Fisheries and Allied Aquacultures
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Introduction: Statement on the rationale and background for the studies

The Florida pompano is one of several species of jacks that are considered highly prized food fish. They are great tasting fish with a flakey texture and a mild flavor. Currently, they are reared in intensive indoor systems and outdoor cages in many areas of the world. Based on ongoing research this species performs well on soy based diets as long as nutritional and palatability needs are met. Previous USB funded projects evaluated the use of soy protein concentrate and selected supplements in marine fish feeds. Further research efforts supported by National Sea Grant Funds have evaluated the use of poultry by-product meal and meat and bone meals as alternatives to fishmeal in soy based diets. This research confirmed methionine and lysine were not deficient in high soy diets (~50% diet) but there was a conditional response to taurine. Given the identification of a taurine limitation, it would be beneficial to re-evaluate the use of soy protein concentrate in practical diets for the Florida pompano and to identify if there are other nutrients that may be limiting.

The objectives of this study are: 1) re-evaluate the use of soy protein concentrate in soy based feed formulations when taurine is supplemented to the diet; 2) conduct a growout trial with soy based and fishmeal based diets; and 3) use growth trial results to perform cost/benefit analyses comparing high soy diets to traditional feed formulation.

Studies completed - brief summary of the number and type of studies conducted, including general study design and approach on how and where the studies were conducted, but without details of the materials and methods

Study 1: Re-evaluate the use of soy protein concentrate (SPC) in soy based feed formulations when taurine is supplemented to the diet.

In previous research with Florida pompano, *Trachinotus carolinus*, we have successfully demonstrated an increased use of soybean meal and soy protein concentrate in formulated feeds

for this species. Increases in the inclusion level of soy products has been primarily driven by identifying limiting nutrients to supplement to the diets as fishmeal is removed. With the present information on nutrient limitations we can replace the fishmeal with other animal proteins at equivalent levels of inclusion but have been limited to a minimum of 15% inclusion. Previous work lead to the conclusion there is a dietary taurine requirement (which will be quantified next year) and appears to be a key measure in developing a successful substitution strategy. With this information we may be able to reduce the animal protein content and possibly eliminate it, producing a plant based diet. To demonstrate the potential of high soy diets (with replete taurine supplementation) two experiments were conducted. The first trial utilized a fishmeal free basal diet containing 15% poultry meal and 39.5% soybean meal. The soybean meal was then substituted with SPC, which allowed the evaluation of SPC without the confounding effects of replacing an animal protein with a plant protein. Four additional diets were formulated that substituted poultry by product meal with SPC thus evaluating the replacement of animal meal with a plant protein.

Study 2: Conduct a grow out trial with soy based and fishmeal based diets.

To demonstrate the potential of high soy diets, three diets were produced by Kansas State University (KSU) under commercial extrusion conditions. These included two open feed formulations which included a high soybean meal (47.5%), one with poultry meal by-product meal (15% diet) and an equivalent diet using soy protein concentrate as a replacement for the poultry meal, the third containing fishmeal, meat and bone meal and soybean meal as the primary protein sources. Two of the diets, soybean meal (SBM) and fishmeal (FM) based diets were used in the previous year (Diets 1 and 3, respectively). The amino acid composition of the three demonstration diets was analyzed by Midwest Laboratories, Omaha, NE.

Study 3: Use growth trial results to perform a cost/benefit analysis comparing soy based diets to traditional feed formulation.

In USB 1463 high inclusion rates of soybean meal supplemented with taurine feeds supported good Pompano growth. The addition of taurine to fishmeal free diets did not substantially increase the cost of producing diets. The estimated feed cost in 2011 for the soybean meal diet was \$0.908 per kg (\$0.4122/lb) and for the fishmeal diet was \$0.967/kg (\$0.4388/lb). While the cost to manufacture the diets was not significantly different, the feed cost per kg of fish produced was significantly less when fed the soy-based diet. There were no significant differences in the growth performance of pompano when fed either soy diet or fishmeal diet. In 2011, the fish that were grown for 16 weeks, the average feed cost per quantity of fish produced was \$1.73/kg and \$2.10/kg for the soy diet and fishmeal respectively with fish mean weights of 140g.

Results - sequential summary of results, ending with recommendations on soy diet formulations, feeding protocols, economics and other related recommendations

Study 1: Re-evaluate the use of soy protein concentrate (SPC) in soy based feed formulations when taurine is supplemented to the diet.

In the first trial SPC was utilized to replace soybean meal. This allowed for minimal changes in

the protein component to allow for the best evaluation of SPC as a protein source. There were no statistical differences in final weight and survival. However, there were minor differences in percent weight gain and FCR. As the response is not a clear dose response this may be noise in the data or there may be limitation to the use of SPC under the current formulations. The second study, evaluated the replacement of poultry byproduct meal with SPC. For this substitution an animal protein is being replaced by a plant protein, which can result in nutritional difference as well as palatability differences. Statistically, there were no difference in performance of the fish; however, numerically there is a noticeable stepwise decrease in final weights as the level of animal protein is reduced. Based on the general trend of reduced performance, at this time the complete removal of poultry by product meal is not recommended. This result is consistent with a number of trials in which the performance of the fish was reduced as animal protein is removed. This indicates there is a limiting nutrient or a group of nutrients, which is not present in plant based feed formulations. In order to shed light on the issue of possible deficiencies resulting in reduced performance the diets from trial 2 were analyzed for their amino acid profile. Although there are not any clear deficiencies of typical limiting amino acids, valine and glycine were reduced in a stepwise fashion. This may indicate they could have an influence on the fish's performance and there supplementation should be evaluated.

Study 2: Conduct a grow out trial with soy based and fishmeal based diets.

The fish in both grow out trials fed aggressively and had good growth performance; the growth parameters were similar when fed the different diets. There was a negative response for growth and survival observed in the tanks fed the SPC based diet that contained no fishmeal or other animal protein. The FCR was significantly worse in that diet consisting of only plant proteins. This is an equivalent diet to the fourth diet evaluated in trial 2 which also produced reduced performance. This study indicates that Florida pompano perform well when fed soy based diets that are supplemented with taurine although complete removal of other animal proteins still needs investigation.

One complication of the research was that the diet with SPC had not been produced by KSU before and they had difficulty producing the diet. As these are research diets, the time allotted for optimize the extrusion process was inadequate to produce a high quality pellet. As the process was not optimized, the diet did not form uniform pellets and they were not very durable, which created a lot of fine materials during handling and feeding. This may have contributed to the poor FCR albeit the same results were seen in research diets. As there were difficulties processing these feeds another area of research would be to evaluate processing requirements for plant based feeds and the effects of high levels of SPC on processing.

Study 3: Use growth trial results to perform a cost/benefit analysis comparing soy based diets to traditional feed formulation.

The current research trials utilized the two diets from 2011 and a third diet comprised of all soy with soy protein concentrate replacing poultry by-product. The estimated feed cost for 2012, for the soybean meal diet is \$1.023/kg (\$0.4641/lb), for the soy protein concentrate diet is \$1.165/kg (\$0.5273/lb) and for the fishmeal diet was \$1.149/kg (\$0.5212/lb). The costs of each diet were all significantly different ($p < 0.0001$), with the soybean meal diet supplemented with taurine being the least expensive. The cost of the soybean diet without taurine supplemented was estimated to be \$0.988/kg (0.4486/lb). The taurine only added an additional \$1.55 per 100 pounds of feed manufactured.

Similar to the previous year, the soy-based diet was less expensive and produced the same

amount and size of fish, which made the price per kilogram of fish less, than the diet containing fishmeal. The average feed cost per quantity of fish produced for the outdoor trial was significantly different, \$2.06/kg and \$2.57/kg for the soy diet and fishmeal, respectively. For the indoor trial the cost per kg of fish was \$3.10/kg and \$4.26/kg for the soy diet and fishmeal, respectively, which were not significantly different. In both trials the fish fed the SPC diet had poor survival and performance, hence the cost/kg of fish was significantly higher than each the other two diets. The market size of pompano is 450 g; the fish did not reach this size during the grow out trials. Therefore, the feed cost to produce market-sized fish was not calculated. More research needs to be conducted on pompano over 150 g.

Conclusions - summarize overall value of research results and application opportunities by industry

The results of the trials show Florida pompano have good growth when fed a fishmeal free diet that is high in plant proteins, both soybean meal and soy protein concentrate. The cost to produce the soybean meal diets is significantly less expensive than the diet with fishmeal. There was not a significant increase in cost to supplement taurine to the soy based diet. These diets should be looked at with larger fish to estimate cost to market size. The complete removal of animal proteins needs to be investigated as well as additional amino acid supplementation.