Increase Sustainability of Fish Farms with the Development of Value Added Products from Fish and Fish Waste

Final Report
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Region: North Central
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Summary

Part B of this project was to take fish hydrolysate prepared in Part A from five different species, compare the assays of the digestate of each species to see which may most closely match the feed requirements of both perch and bluegill. Therefore, hydrolysates from five species (perch, bluegill, bullhead, tilapia, and rough fish) were compared for their macro and micro nutrients, fatty acid lipids and other essential food components. Given the assays of the five species, the task was to match as close as possible the dietary requirements of perch and bluegill (target species). The feed nutritional outline as provided by "Development of Least-Cost Diets for Fishes: An Example with Bluegill" by the Departments of Fisheries & Wildlife Sciences and Animal Sciences, University of Missouri-Columbia, MO. was used as the basis of feed formulation. Feed formulations were completed by Jerome Donohoe of Agricultural Omega Solutions LLC. The requirements for the feed were to develop an approximate 2mm pellet which was extruded so as to provide a slow sinking product. Because the hydrolysates were liquid based with only 15 to 17% dry weight it would take large quantities of product to meet the ingredient requirements. Alternatively, the hydrolysates could be dried to be able to add a dry product ingredient which would again be too costly. Finally for the feed mill to run several batch tests of grain based feed mixed with hydrolysate would be cost prohibitive. Therefore, it was determined that attempting to use components of hydrolysate to make up the dietary needs of fish feed will be cost prohibitive for small runs. It was concluded from this study that for small farms such as Pepco Aquaculture, it is far more cost effective to use the fish hydrolysate as a

fertilizer. Fish hydrolysate derived from processed fish waste will add value from between 30 to 100% the value of the fish fillet itself.

Objectives/Performance Targets

1. Determine value added to farm operation based on fish Hydrolysate production Completed in Part A of this project.

2. Determine development of a suitable fish pellet from domestic resources

3. Compare economical value of fish pellet and fish Hydrolysate from use of fish waste

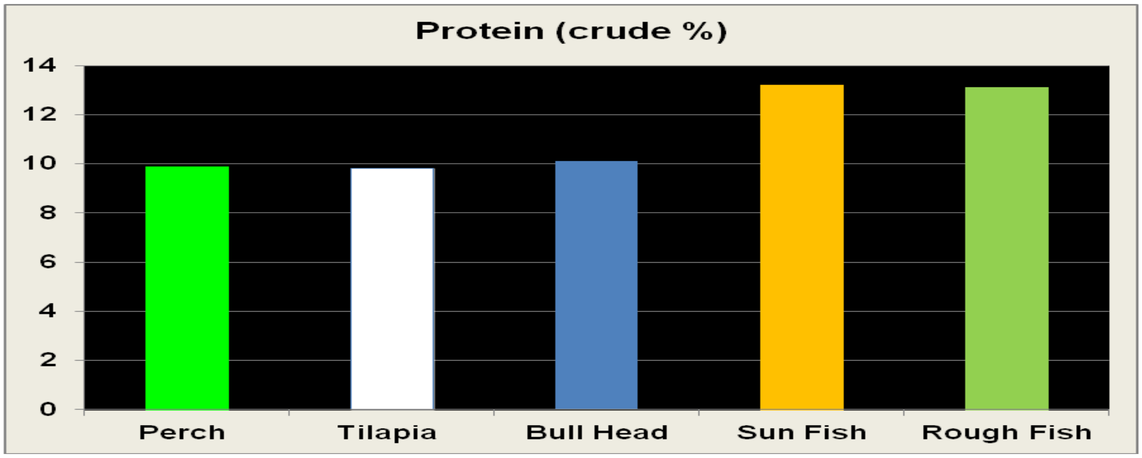
Item 1: As noted above, preparation of a basic fish hydrolysate was completed in Part A of this project. In following up with an additional year of hydrolysate manufacture and testing, we found that there is about a 10:1 ratio of the weight of fish product to the amount of gallons of hydrolysate produced. Therefore, for every 20 pounds of fish waste, there will be about two gallons of hydrolysate produced. This assumes that there is no water added to the product during the hydrolysis process. The value of the hydrolysate will vary based on the size of the container e.g. pint, quart, gallon, or bulk. Comparative values of hydrolysate versus manufactured pellet derived from hydrolysate will be discussed below.

Item 2: Development of suitable fish pellet from domestic resources

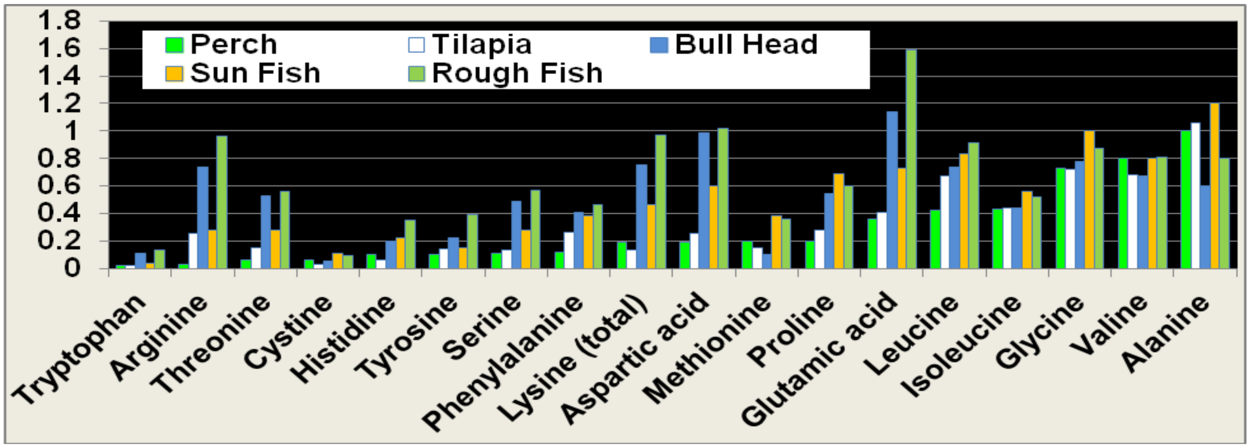
In this work effort, we first generated five hydrolysates from five species of fish which are easily found locally (perch, sunfish, rough fish, tilapia, and bullhead). Complete assays were conducted on each of these species as were assays on target species of perch and bluegill. Our objective was to see which of the five species more closely matched the target species which we want to grow out. The data provided in the following graphs shows the results of our assays.

One note, for perch, hydrolysates were derived from only the waste from processing. All other fish hydrolysates were from whole fish.

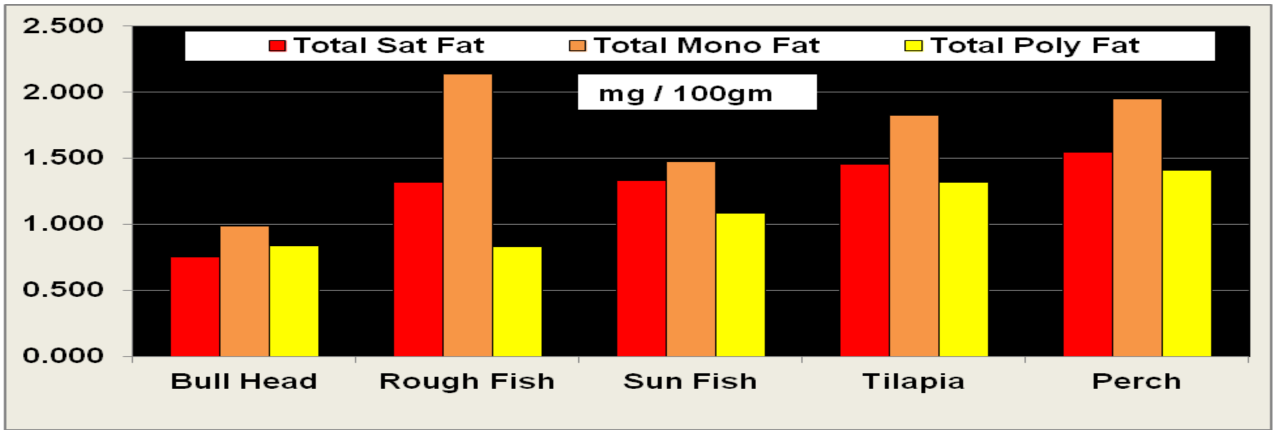
Total Proteins



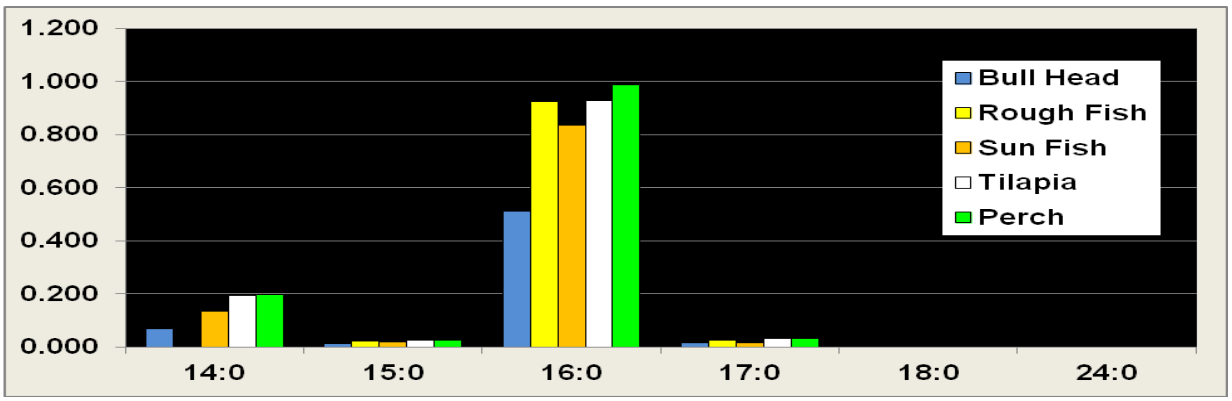
Amino Acid Breakdown of Proteins in %



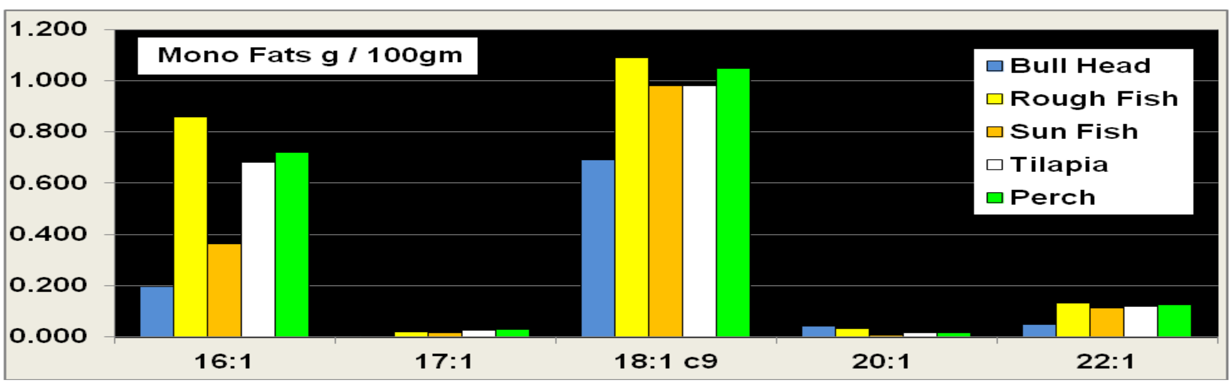
Total Fats



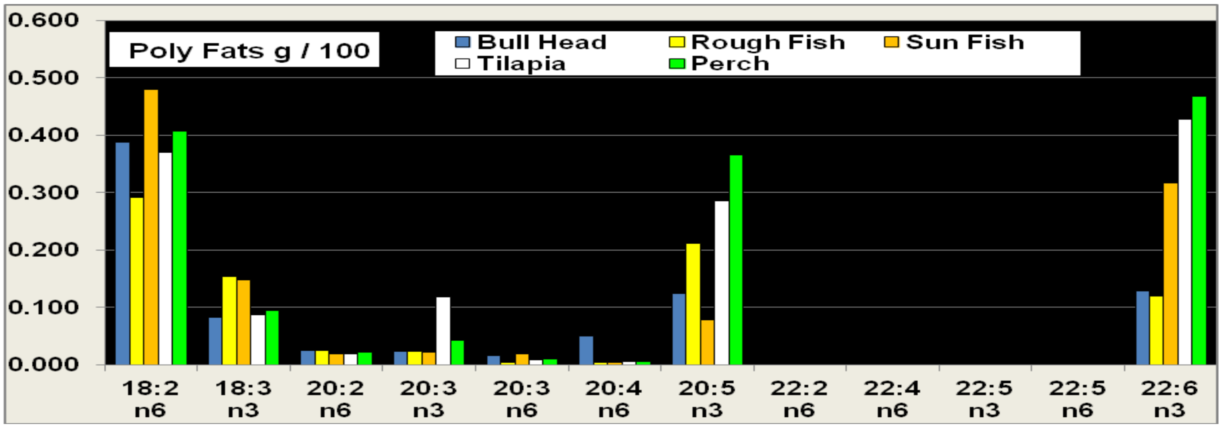
Saturated Fats



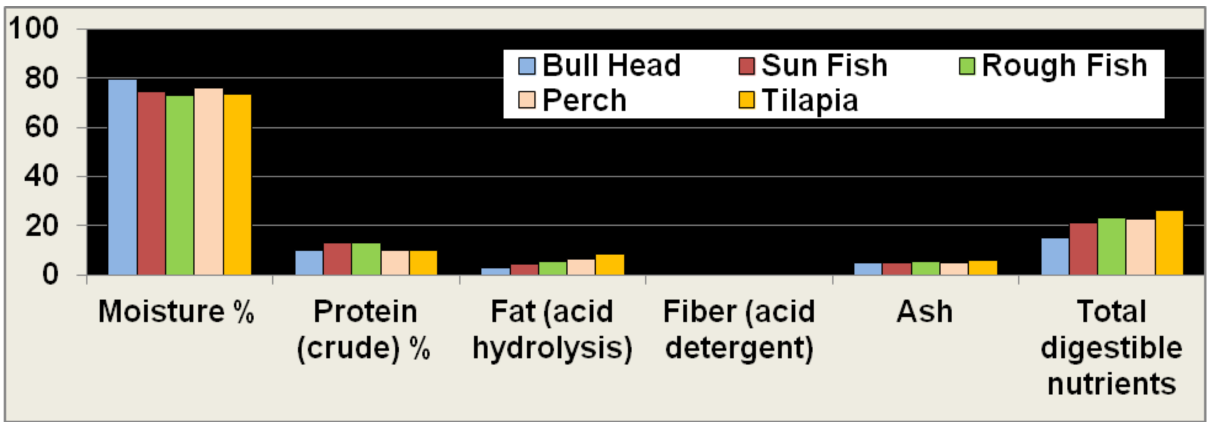
Monounsaturated Fats



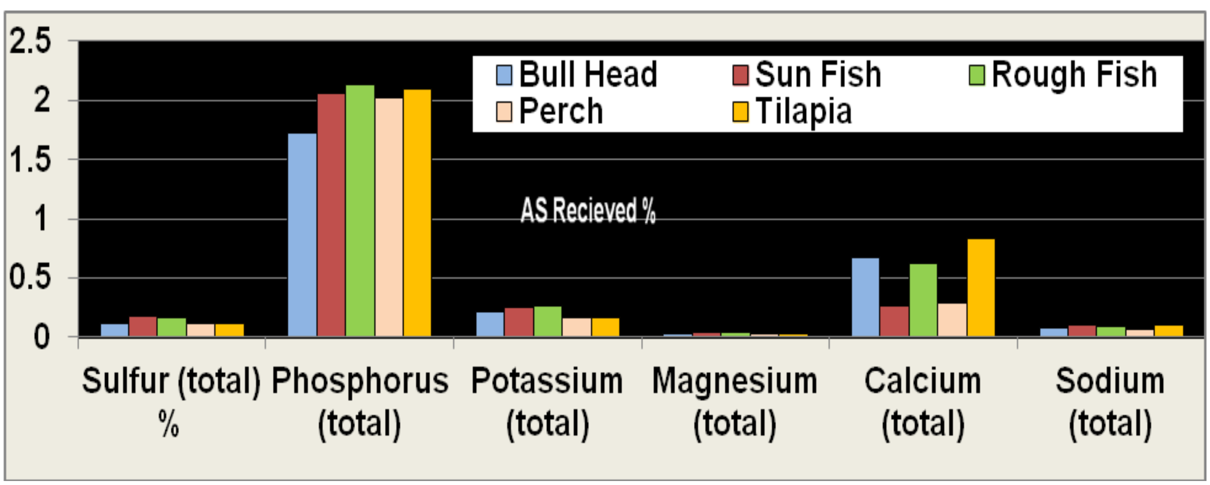
Polyunsaturated Fats



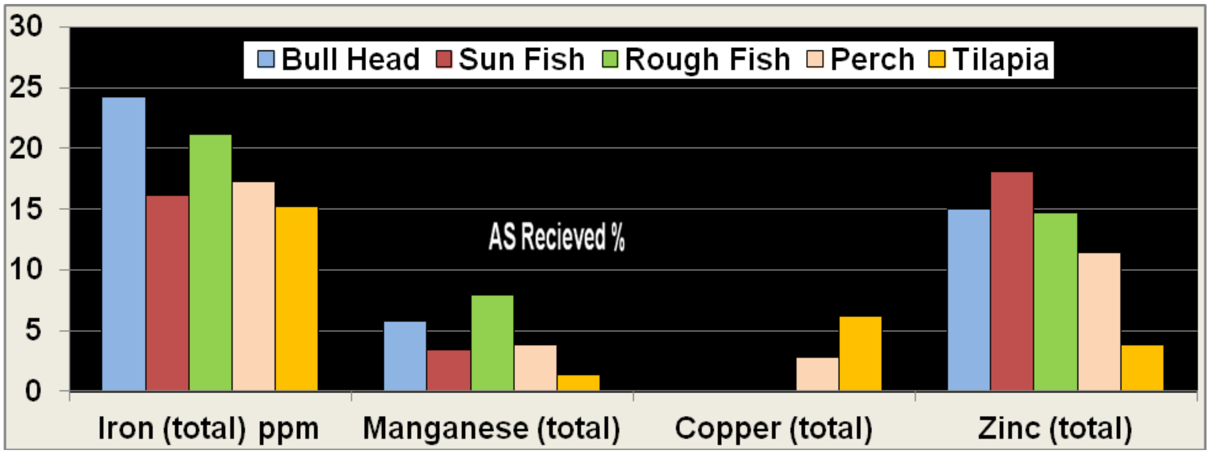
Total Proximate



Minerals



Minerals



From the information obtained from the assays, we would be able to take the derived fresh fish hydrolysate nutrient composition of proteins, fatty lipids and mineral valued to convert along with other nutrient rich feed stock ingredients into a pelletized fish feed ration. In working through the prospect of manufacturing a fish feed, we used the feed nutritional outline as provided by "Development of Least-Cost Diets for Fishes: An Example with Bluegill" which was prepared for a North Central Regional Aquaculture Center (NCRAC) project. This was outlined by the Department of Fisheries & Wildlife Sciences and Animal Sciences, University of Missouri-Columbia, MO. The feed ration was evaluated by the feed mill which needed to process the feed into an extruded 2mm pellet form – slightly floating but more so slow sink.

After obtaining suitable ingredients and a pelletizing procedure, it was determined that it would cost approximately $3500/hr to create the feed and a minimum of a four batch run would be warranted to create the test runs needed for this study. Because the cost for making a small run far exceeded the cost of making hydrolysate alone or for the value of the pellet, it was obvious that the cost would be too high.

An issue that complicated the procedure was that the hydrolysate was a liquid. From the charts, one can see that the percent solids is below 20% and the protein level was from 10 to 12%. Therefore it would have been easier to dry the hydrolysate to work with a dry product (not an easy task) for the sake of working with all dry ingredients. However, we did learn that the pelletizer could incorporate a liquid fraction but we would have needed to add sufficiently higher quantities of hydrolysate to boost the protein fraction in the pellet. In doing so we would have had to compensate for all the other components which were part of the hydrolysate.

Item 3: Compare value and costs of hydrolysate production and pellet production.

In this task, we were to determine the value of the hydrolysate versus the value of the feed pellets. Since in either case, we would have to make hydrolysate, it was determined that making a pellet from components of the hydrolysate far exceeded the return value of the pellet versus the value of the hydrolysate. It would be far better to sell the hydrolysate and use the income to purchase feed. It would also appear that to make fish feed from domestic fish meal sources, one would need a substantial user base such as a cooperative to approach the endeavor.

Impacts and Contributions/Outcomes

The manufacture of fish hydrolysate from waste fish products is very straight forward. There are issues that need to be considered in order to make a stable product. One thing that was not undertaken was to determine the stability of the product either when used as a fertilizer or when used as a feed supplement i.e., what is the shelf life?

We know that fish hydrolysate will add to the bottom line. Depending on how the hydrolysate is packaged, the hydrolysate will add a substantial amount of income. As an example, if we assume that perch and bluegill can yield an average of 40% (high for bluegill but low for perch) then for every pound of fish processed, we will have 40% meat and 60% waste. Assume also that perch and bluegill can now be sold for $12 per pound. Therefore, for every 100 pounds of fish we will get $480. Likewise we will get 60 pounds of waste which will convert to 6 gallons of hydrolysate. This hydrolysate can be sold between $150 and $500 again depending on packaging. We therefore see that the value of hydrolysate will be roughly between 30 and 100% the value of the fillet.

The impact of hydrolysate production is actually more significant than that. Most farms with medium to large ponds inherit volunteer fish which are generally contributed by birds. These species include bullhead, minnows, green sunfish, and others. All of these fish can be used 100% for the purposes of making hydrolysate. Likewise, if a species grown in an aquaponics system cannot meet a breakeven value as a fillet, it can more than serve as a component of hydrolysate production. The information generated by this project will allow growers to identify and make financial decisions relative to the disposition of fish and fish waste which here to for may not have been considered.

One of the outcomes of this project which is just now being assessed is the overall benefits of hydrolysate. We did learn that some states (Wisconsin in this case) require one to obtain a fertilizer license for manufacturing and selling this product even if it is not called a fertilizer. The product is listed as an organic soil amendment and can be listed under an organic label such as OMRI.

Field trials conducted by Pepco Aquaculture and other users of the product over the past year have indicated that the product significantly improves growth and production of those plants tested including all vegetable crops, trees, bushes, flower gardens, lawns and even deer plots. The hydrolysate may work better as a foliar spray (great success) but works very well as a liquid in irrigation systems. Sample pictures of product use follow.

After eight years of nearly no growth, fish fertilizer was added as a liquid. The lower orange tie on the pole is year eight. The second tie represents year nine growth (14 inches) and by June the following year (2015) there was already nine inches.

Carrots germinated using fish hydrolysate. Instead of a two week wait for germination, the carrots germinated in two days and were six inches tall in two weeks. By June 15, there were almost a foot tall and had a tap root about 1.5 inches in diameter. The row near the bucket is carrots from seed planted directly in the ground while the end of the same row are the carrots that received the fish hydrolysate.

Vine crops can also be sprayed using the foliar spray technique. However, here we use a gallon jug add one tablespoon of hydrolysate and place the jug by the roots of the hill. This way, the roots get a continuous supply of water and fertilizer. In this case, the melons started blooming within two days of application.

Here is a picture of two techniques. The main garden received a foliar application as did the raspberries in the background. The melons on the left receive hydrolysate in a jug of water which is the drip technique. We planted two types of peas (regular and snow peas). While it would not seem that peas need the extra fertilizer, our pods averaged five inches with many in the seven inch size.

We did a foliar spray of raspberries but not sure if we should have done that or just irrigated the roots. In any event by using the foliar spray, the plants grew to five feet and bore tremendously. The bloom was so heavy we generated significant honey from resident hives.

There are about a dozen Nanking cherries in this picture. Because we have a number of plants, we could choose to foliar spray every other plant. This picture was taken in November after most deciduous trees had lost their leaves. Note that the two bushes sprayed with hydrolysate retained their leaves. The tremendous foliage hid the cherries from the birds.

Though the hydrolysate is derived 100% from fish, the cold digestion process does not allow the finished product to have a fish odor. We can therefore use it on our house plants as well as in our aquaponics/hydroponics/greenhouses