



## The Plant Products in Aquafeed Working Group

February 20, 2008

Alternative Feeds Initiative  
NOAA Aquaculture Program  
1315 East-West Highway, Rm 13117  
Silver Springs, MD 20910

Dear Sir or Madam:

The Plant Products in Aquafeed (PPA) Working Group welcomes the collaboration between NOAA and USDA that will focus on the development of alternatives to fish oil and meal in aquaculture diets.

The Plant Products in Aquafeed Working Group is an informal group of researchers working collaboratively and strategically to identify and conduct the research needed to increase the use of plant feedstuffs in the diets of cultured marine finfish. Information on PPA can be found on the [Aquafeed.com](http://Aquafeed.com) website. The international experts who comprise PPA have authored and published two papers in peer-reviewed journals, "[Expanding the Utilization of Sustainable Plant Products in Aquafeeds](#)" and "[The Plant Products in Aquafeed Working Group Strategic Research Plan](#)" (in press). The PPA Working Group continues to work toward implementation of the Strategic Plan and, at the request of USDA/CSREES, is in the process of drafting a "tactical plan" to guide implementation. The United Soybean Board (USB) has supported the PPA Strategic planning process with resources and staff. USDA/ARS National Program Staff - both from the plant feedstock side as well as aquaculture have encouraged the PPA process. In addition, PPA is grateful to others in the public and private sectors - the National Oceanic and Atmospheric Administration (NOAA), the US Soybean Export Council (USSEC), the USB and Silvercup Feeds as well as USDA/ARS have made the PPA Working Group meetings possible.

In response to the questions posed by NOAA and USDA, we submit the following:

*(1) Groundbreaking research on alternative dietary ingredients (feedstuffs) for aquaculture, including plant-based proteins, is expanding in the United States and worldwide. Where should the federal government focus its research efforts in the area of alternative feeds for aquaculture? Are there specific areas that the federal government should not address?*

- "[The Plant Products in Aquafeed Working Group Strategic Research Plan](#) is a roadmap for coordinating and enhancing the development of new research programs and projects. It is a comprehensive and coherent research agenda for addressing the problems encountered when developing plant-based aquaculture diets. The plan describes seven research goals with objectives and performance measures and includes a spectrum of basic and applied research. Seven writing teams comprised of international experts drafted the "roadmap" of the research steps or performance measures needed to accomplish the seven goals. We strongly recommend that NOAA and USDA research on plant-based diets start with these seven goals and performance measures:

- Establish standardized research approaches and protocols for systematic evaluation of plant feedstuffs across carnivorous fish species.
  - Enhance fish germplasm and discover genes.
  - Enhance the inherent composition of crops to provide a beneficial balance of bioactive compounds in order to optimize their use in aquafeeds for carnivorous fish.
  - Increase understanding of interactions between gastrointestinal microflora and plant tolerance in fish.
  - Improve and optimize ingredient processing, feed manufacturing technology, and feed formulations to increase inclusion of plant-derived ingredients in the diet of carnivorous fish.
  - Optimize the storage, nutritional and sensory quality of aquaculture species for human consumption.
  - Develop an international communications network for research on optimizing plant products in aquafeed.
- We also strongly recommend that NOAA and USDA initiate a strategic planning process for research on all alternative protein sources, building on the PPA Strategic Plan,
  - that experts from a broad range of disciplines be involved in the process (e.g. nutritionists for other livestock species, nutritionists for other carnivorous species, plant genomicists, human health scientists, marine ecologists), and that all of the U.S. technical agencies be involved. It is important, for example, that NOAA and USDA work with the National Science Foundation (NSF) so that agency can be made aware of research needs related to basic fish biology including a better understanding of the phylogenetic relationships among fish species; and that understanding gained through zebrafish genomics be translated to domesticated species.
  - Because most freshwater finfish species are omnivorous, there is little research needed to minimize the use of fish meal in those diets. Nevertheless, there is a significant amount of work needed to develop diets for juveniles such as carp, the source of the largest demand for fishmeal among all aquacultured species.

*(2) What are potential alternative sources of protein and oil for aquaculture feeds? For example, are there specific opportunities for greater use of seafood processing waste and other agricultural by-products in aquaculture feeds? Are there specific obstacles to using these alternatives as dietary ingredients in aquafeeds?*

The plant feedstuffs considered in "[Expanding the Utilization of Sustainable Plant Products in Aquafeeds](#)" document include oilseeds, legumes and cereal grains which traditionally have been used as protein or energy concentrates as well as novel products developed through various processing technologies. This review paper also surveys the obstacles to using plant-based proteins.

*(3) What type of treatments or processes show promise for improvement of existing aquaculture feedstuffs and for developing new feedstuffs? How soon could these technologies be commercialized?*

- The first performance measure under Goal 5 (re: processing) in the PPA Strategic Plan is to **Compile a list of enhanced products and manufacturing**

technologies. We suggest to “the Initiative” that it would be appropriate to compile the information from the public’s input to serve as a starting point for this list.

- Another performance measure states - **Determine the effects of processing technology on bioavailability of required nutrients and other biologically active compounds that have a positive or negative activity.** It is clear that to process factors “in” or “out”, the compounds that affect the fish positively or negatively must first be identified.

Therefore, we urge NOAA and USDA to provide the remainder of the funding to the National Research Council (NRC) to update the volume, *Nutrient Requirements of Fish*, 1993, and propose that NRC be asked to focus on finfish leaving other aquacultured species including crustaceans to a separate study as has been done in the past. The NRC study should provide the information necessary to guide future developments in processing and point to possible productive directions for research.

- To be a viable alternative feedstuff to fish meal in aquafeeds, a candidate ingredient must possess certain characteristics, including wide availability, competitive price, plus ease of handling, shipping, storage and use in feed production. Further, it must possess certain nutritional characteristics, such as low levels of fiber, starch, especially non-soluble carbohydrates, and anti-nutrients, plus have a relatively high protein content, favorable amino acid profile, high nutrient digestibility, and reasonable palatability. Although some plant-derived ingredients, such as soy protein concentrate or wheat gluten, possess most of these characteristics, they have been too expensive relative to the price of fish meal to be used in most aquafeeds. Therefore, the expertise in fermentation and other bioprocessing from all of the Federal technical agencies might be called into play under the auspices of an inter-agency working group.

*(4) Fish meal and fish oil contribute important human nutritional components to aquaculture feeds such as omega 3 fatty acids. As the aquaculture feeds industry seeks to replace fish meal and fish oil with alternatives, how can the nutritional benefits of farmed seafood be maintained or enhanced? For example, what technologies exist for producing omega 3 fatty acids?*

A performance measure in the PPA Strategic Plan states:  
Characterize the nutritional quality to humans of aquacultured carnivorous species raised on feeds that optimize the inclusion of plant products.

*Baseline: A great deal of information exists on what nutrients should be in the human diet and what compounds are anti-nutrients. This information needs to be brought together and compared with fish compositional data.*

*Target 2008: Determine through literature review and synthesis what compounds should be surveyed and determine which are likely to change during a transition from fish meal-based diets to plant meal-based diets and which are unique plant components that may be transferred to the fish with plant based-feeds. This includes both health promoting and health endangering compounds. Communicate with groups raising fish fed plant diets for other reasons.*

*Target 2010: Piggy back on other growth studies to determine what characteristics change with plant-based feeds that are nutritionally relevant to humans. Conduct directed studies to develop methods to overcome potential issues with human health (e.g. fatty acids, isoflavonoids, alkaloids, glucosinolates etc.) Conduct studies to develop diets for fish that improve the healthiness of products (e.g. fatty acids, vitamins, carotenoids etc).*

In order to most efficiently and effectively use existing resources to identify research needed to culture fish that are optimally nutritious to consumers, the PPA recommends that the NOAA-USDA Initiative involve the wider research communities within both NOAA and USDA (such as the Human Nutrition Program areas at ARS and CSREES) as well as NIH.

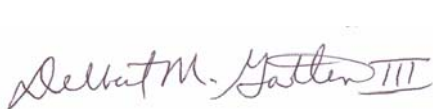
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In summary, the Plant Products in Aquafeed Working Group welcomes and supports the NOAA-USDA Initiative. PPA is proud of our success in advancing the understanding of alternative sources of protein in aquaculture diets, but acknowledge that there is a tremendous amount of work yet to be done; that goals such as “Establish standardized research approaches and protocols for systematic evaluation of plant feedstuffs across carnivorous fish species” are critical to moving forward, but will require effective cooperation and collaboration - arguably cooperation and collaboration that can only be provided by collaboration among the technical agencies. It may be that the Joint Subcommittee on Aquaculture (JSA) provides the necessary structure for an inter-agency collaboration.

We urge you to move forward with developing a strategic planning process and to expeditiously implement the research plan that evolves from that process. The U.S. has the opportunity to lead the world in the replacement of fishmeal and oil with alternatives - but to do so will require considerably more than additional talks and meetings. While new funding never hurts, it is not needed for quantifiable progress. What is needed is cooperation, planning and aligning existing resources to address this national priority with all of the acknowledged trade, economic and environmental implications.

With all of these forces aligned - economic, environmental, biobased fuels, human nutrition - surely it is time to resolve the researchable questions that stand in the way of using sustainable protein and oil sources in aquaculture diets.

On behalf of the Plant Products in Aquafeed Working Group,



Delbert Gatlin, Ph.D., Chair



Rick Barrows, Ph.D., Vice-Chair

**The Plant Products in Aquafeed Working Group is an alliance of experts for the purpose of breaking down the researchable barriers to increasing the use of renewable and sustainable plant feedstuffs to fill the demands not only of the aquaculture and feed industries, but of the consumer, for a supply of nutritious seafood.**