

Total Replacement of Fish Meal and Fish Oil in Diets for Nile Tilapia and the Marine Obligate Carnivore, cobia.

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Questions addressed by this paper:

- 1) What alternative technologies are available or in development to fish meal and fish oil replacement?
- 2) Would these alternatives meet the principles of organic production for allowance as a feed source?
- 5) What is the state-of-the-art with regard to minimum percentages of fish meal and fish oil needed in feeds that traditionally rely upon these ingredients?

Research on alternate protein and lipid sources at the Virginia Tech Aquaculture Center (VTAC) has involved a multi-species, multi-trophic level approach focusing on traditional as well as organically certifiable ingredients. Species that have been investigated include tilapia, marine shrimp (*L. vannamei*) and cobia. Alternate proteins investigated include single cell yeast proteins, soybean meal, organic soybean meal, organic soy concentrate and isolates, organic hemp meal and an organically produced worm meal (*Neried sp.*) from a supplier in the UK. All studies undertaken utilized a step-wise inclusion rate (replacing fish meal) culminating in a diet composed entirely of the alternate protein being investigated. Supplemental amino acids were utilized in several of the studies, usually methionine, but also taurine, an essential amino acid for the true cats. Lysine was supplemented in specific studies.

While there are a number of suitable alternate protein sources from the traditional agriculture sector, ie soybean meals and associated products, these numbers dwindle rapidly when one focuses upon **organically certified** alternate proteins. This will be a major obstacle to the future development of true organic seafood production. Alternate proteins and lipids are critical for sustainability issues with regards to traditional aquaculture, they certainly are no less important for the organic community. However, alternate feeding strategies and/or production methodologies must also be investigated for organic aquaculture. These will and must include, but most certainly are not limited to, potential protein sources from other organic industries, specifically the organic poultry industry, as well as composted materials that utilize “waste” products from other organic sectors. While we must be attentive and exclusionary of many traditional protein and lipid sources, we also must be proactive in the development, production and distribution of truly alternative forms of nutrients that usually are not considered in traditional food production scenarios. Thermophilic composting, for example, has a vast literature citation base with supporting scientific information that all pathogenic microorganisms are killed during the composting procedures. While the public perception component of this cannot be ignored, it must be changed utilizing the best available scientific investigations. We cannot afford to simply let public perception eliminate potential forms of alternate nutrients and/or production systems under organically certifiable guidelines.

The above point is also made very eloquently when discussing utilization of “waste” protein sources from other organic production sectors, ie the organic poultry industry. If organic aquaculture is to have a chance at survival, we must make these protein sources available for aquafeed manufacture. It is part of the organic mantra that waste streams be utilized, that carbon be recycled and that nutrients are utilized to their fullest extent. All of these mandates are satisfied when and if the aquaculture industry could utilize offal, feather and poultry-by-product meals from the organic poultry industry. Presumptions, preconceived notions and bias within the organic community must be put aside if a true, sustainable organic food production industry is to thrive in this country. We cannot let such a valuable source of nutrients go unutilized and we must develop methodologies that will allow these, and other similarly scrutinized “waste” streams from other organic production sectors, to be utilized in aquafeeds.

Fish meal and fish oil inclusion rates have dropped in aquafeeds, but since overall production levels have skyrocketed in the past twenty to thirty years, net usage has increased. The salmonid industry, much maligned in the press and through NGO's, has actually significantly decreased fish meal and fish oil usage in their formulations over the past 20 years. Granted, these reductions have ultimately been the result of economics, but increased feed conversion rates and better feeding strategies tied to state-of-the-art nutritional sciences have been instrumental in the ability to reduce the inclusion levels of these key nutrients. We still can do much better, but some species simply will require some level of fish meal and fish oil for the foreseeable future. There are many interesting technologies arising in the feed industry that give great hope of the eventual elimination of fish meal and fish oil, but a vast majority of these technologies are many years from successful commercial applications. However, to simply wait for these technologies to become available is simply not acceptable. The proposed 12% limits on fish meal and fish oil (24% of diet total) are a good starting point for organic aquaculture, and we should embrace them so that we can allow an industry that is ripe for expansion that ability to do so. This, bearing in mind that production of organically certifiable marine carnivores such as Atlantic salmon or cobia SHOULD be difficult, and by extension, more expensive. ***The most important aspect of organic production is the protection of the organic label.*** If the power of this label is diluted, or the threshold lowered to ease production costs, or make the production of organic seafood “easier”, then we will have failed the basic tenants of the organic production model. I certainly feel from a personal research perspective that we in the nutritional sciences can eventually eliminate fish meal and fish oil from aquafeed formulations. This is an issue that is germane not only to the future organic aquaculture movement, but to traditional aquaculture production as well. Traditional aquaculture must move away from fish meal and fish oil if production is to remain sustainable during the rapid expansion of the industry that is mandatory to supply the upcoming seafood gap in terms of supply and demand. We, as an industry, must focus upon the need to double global production in the next 25 years. To accomplish such a monumental feat, traditional feed formulations that rely upon fish meal and fish oil simply are not feasible. So, in this respect, the organic aquaculture and traditional aquaculture industries have many of the same issues with respect to fish meal and fish oil. From the organic perspective, fish meal and fish oil from wild caught fisheries are viewed as either non-sustainable (this is changing as many fisheries are being certified as being “sustainable”), contaminant-laden, or

simply unsuitable for organic production. However, a case could be made that many fish “require” fish meal for health and welfare. The key question is whether these fish are themselves suitable for organic certification or should they simply be viewed as incompatible with the organic guidelines. These fish are the marine carnivores, the most high value and popular of finfish species. In my opinion, by limiting fish meal and fish oil inclusion at 12 and 12%, respectively, the bar is being set fairly high, while still exclusionary, it is also attainable. From the traditional aquaculture production perspective, high levels of fish meal and fish oil are simply non-sustainable from an economic perspective and that is the major impetus for the move away from these traditional protein and lipid sources. It is true that some contamination issues hover around fish meal and fish oil and that these impact the departure from high inclusion levels in aquafeeds, but in the end, it is all about the economics and the economics unequivocally state that continued reliance upon these traditional feedstuffs for aquafeeds is simply not profitable.

Total elimination of fish meal from organic aquaculture will necessitate supplemental amino acid inclusion, and thus inclusion of several amino acids on the National List, based upon health and welfare issues related to organic production guidelines. Research at the VTAC has relied upon methionine, taurine and lysine supplementation for optimal performance and health of cobia. These issues remain to be dealt with in terms of these proposed guidelines on fish meal inclusion levels. If they remain at the initially prescribed levels of 12%, then amino acid supplementation could be eliminated by blending several protein sources to replace fish meal. If these inclusion levels are to be phased out over a period of time, then technology, alternate organically certifiable protein sources or listing of supplemental amino acids on the National List are the only true mechanisms for overcoming the problem of inadequate amino acid nutrition due to lack of fish meal. Fish oil inclusion is another matter as there are currently several available algal sources of EPA and DHA, the essential n-3 fatty acids that all marine fish require, albeit, they are presently costly. As discussed earlier, the fact that organic formulations are more costly is not a satisfactory reason for policy...again, it should be difficult to produce an organic marine finfish carnivore! There are also several new technologies on the horizon that may aid in the elimination of fish oil from organically certified aquafeeds that do not involve genetically modified organisms. This issue is more likely an easier one to solve than the ones surrounding fish meal inclusion in organic aquafeeds.

In summary, fish meal and fish oil inclusion at 12% each seems to be a good starting point for inclusion in acceptable guidelines for organic aquaculture production. We must move past this area so that the industry can expand as it is so poised to do, as well as protect the organic label and move onto equal footing of other countries with already established organic aquaculture guidelines and industries. Whether these numbers are to be maintained or eventually phased out introduces many additional issues that must be addressed, especially from the standpoint of fish meal inclusion based upon the health and welfare of the cultured fish species. Fish oil should be an “easier” issue as many commercial forms of organically certifiable sources for n-3 fatty acids, the fatty acids so recognizable for their benefits to human nutrition, are already available and many more are in the developmental stages. These, along with the issues surrounding

alternate protein sources from other organic sectors and alternate feeding/production strategies that involve thermophilic composting, must be addressed and solved so that organic aquaculture guidelines that preserve the organic label can be implemented in the United States.