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DIARY DATES
The global aquaculture industry currently accounts for over 45% of all seafood consumed. That figure has been projected to increase to 75% over the next 20 years. While the aquaculture industry is truly on a dynamic growth path, it is none-the-less dangerously dependent on fishmeal as a key protein constituent in fish and shrimp diets. The aquaculture industry is not alone however, as cattle, poultry, hog and mink producers utilize fishmeal as the primary protein source in their diets as well. Currently 10 countries produce 80% of world fishmeal supply, and three of those suppliers are net importers of product, thereby reducing supply, not increasing it. These include the U.S. and China. Production of fishmeal decreased 20% in 2006, and prices rose from $750/tonne to over $1400/tonne. U.S. growers experienced four feed price increases within a 16 month period. A staggering 25% of all world fish production goes into fishmeal and fish oil. Because world supply is so isolated geographically, every tonne of fishmeal travels an average of 5000 km before it reaches the end user. This has enormous economic implications in supplying the global markets. Clearly the future demand for fishmeal is on a rapidly increasing track. With world fish stocks, and baitfish stocks in particular, in decline, the stage is set for a bottleneck that could severely limit industry growth. In order to head off such a bottleneck, the industry must eliminate its dependence upon fishmeal (and fish oil) and develop sustainable dietary protein sources that can be commercially produced with all natural and organic products.

**ALTERNATIVE PROTEIN SOURCES**

Plant-based proteins have been around for many years. Grains such as soybean, wheat, and corn are commonly incorporated in small amounts in many fish diets. Currently 10 countries produce 80% of world fishmeal supply, and three of those suppliers are net importers of product, thereby reducing supply, not increasing it. These include the U.S. and China. Production of fishmeal decreased 20% in 2006, and prices rose from $750/tonne to over $1400/tonne. U.S. growers experienced four feed price increases within a 16 month period. A staggering 25% of all world fish production goes into fishmeal and fish oil. Because world supply is so isolated geographically, every tonne of fishmeal travels an average of 5000 km before it reaches the end user. This has enormous economic implications in supplying the global markets. Clearly the future demand for fishmeal is on a rapidly increasing track. With world fish stocks, and baitfish stocks in particular, in decline, the stage is set for a bottleneck that could severely limit industry growth. In order to head off such a bottleneck, the industry must eliminate its dependence upon fishmeal (and fish oil) and develop sustainable dietary protein sources that can be commercially produced with all natural and organic products.

**ALTERNATIVE PROTEIN SOURCES**

Plant-based proteins have been around for many years. Grains such as soybean, wheat, and corn are commonly incorporated in small amounts in many fish diets. Plant-based by-products such as the distilled dried grains with solubles (DDGS) from ethanol production, and other similar products from other bio-diesel are now becoming more available, however are generally lower in protein than the original grains themselves. Seaweeds and algae have also been used on a limited basis in fish and shrimp diets, and further research is underway to evaluate the quality and quantity of different sources. In general, plant-based proteins are inferior in quality and amino acid profiles to animal proteins and therefore to date have not proven to be adequate substitutes in carnivorous fish/shrimp diets, as the digestibility and feed conversion ratios are generally lower.

Insects offer a promising solution to the protein bottleneck

Insect-based protein may soon be available to meet species specific dietary needs

*By Ernest D. Papadoyianis, Neptune Industries, Inc.*
Diets of omnivorous species such as catfish and tilapia however may incorporate plant proteins and achieve reasonable conversion ratios. Bacteria-based proteins are currently being researched and while the initial data on quality of the proteins appears favorable, the economics are in question. Animal proteins typically used in fish diets include poultry meal, feather meal, blood meal, and with less frequency, beef heart, collagen protein, etc. Animal proteins have superior amino acid profiles to plant proteins, as well as higher overall protein content. While superior to plant protein, these animal proteins are not foods naturally eaten by fish, and therefore have certain nutritional shortcomings relative to fishmeal.

"Limiting amino acids such as Methionine, Lysine, and Arginine as well as omega-3 and -6 fatty acids are critical to fish growth, health and development.

<table>
<thead>
<tr>
<th></th>
<th>Fishmeal*</th>
<th>Soybean meal ^</th>
<th>Ento-protein**</th>
<th>Poultry meal^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Protein</td>
<td>62-67</td>
<td>47</td>
<td>41.58 - 62.47</td>
<td>67</td>
</tr>
<tr>
<td>Fat</td>
<td>8-12</td>
<td>1.56</td>
<td>20.21 – 51.48</td>
<td>10.87</td>
</tr>
<tr>
<td>Ash</td>
<td>16-21</td>
<td>5.80</td>
<td>2.41 – 9.03</td>
<td>13.98</td>
</tr>
<tr>
<td>Omega 6</td>
<td>0.89</td>
<td>0.40</td>
<td>3.90 – 10.74</td>
<td>2.00</td>
</tr>
<tr>
<td>Omega 3</td>
<td>2.02</td>
<td>0.05</td>
<td>0.15 - 0.39</td>
<td>0.10</td>
</tr>
<tr>
<td>Limiting Amino Acid (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methionine</td>
<td>1.75</td>
<td>0.68</td>
<td>0.55 – 1.02</td>
<td>0.86 – 1.03</td>
</tr>
<tr>
<td>Lysine</td>
<td>4.88</td>
<td>3.03</td>
<td>2.01 – 3.60</td>
<td>2.65 – 2.81</td>
</tr>
<tr>
<td>Arginine</td>
<td>4.24</td>
<td>3.51</td>
<td>1.94 - 3.68</td>
<td>2.28 – 3.69</td>
</tr>
</tbody>
</table>

^ Analysis courtesy of Zeigler Bros.
HOW DO THEY COMPARE WITH FISH-MEAL?

Plant
- May provide adequate protein quality for omnivorous species such as tilapia and catfish.
- By-product waste generally lower in protein composition and quality than processed grains.
Seaweeds and Algae while high in minerals are typically lower in protein

Bacterial
- May provide higher grade protein than plants
- Experimental at this time

Animal – Poultry, Blood and Feather
(> see Table 1.)
- Good supplemental protein source but lacks amino acid profile to fully replace fish meal
- Many seafood buyers & chefs shun the use of mammalian/avian products in the diets
Will they qualify for organic certification?

Animal – Invertebrates
- Broad diversity of species
- May hold the greatest potential for sustainable production
- Many have good amino acid and digestibility profiles
- Provide natural food sources in the wild
- Extensive research is needed

Will commercial production be economical?
One class of invertebrates has drawn particular attention – Insects. Neptune Industries, Inc. (NI) has filed a process patent on the production protocol for a product called Ento-Protein. Ento-Protein is a high quality dry protein meal created from commercially raised and processed insects.

Through a cooperative research effort with Mississippi State University (MSU), NI is in the beginning stages of assessing Ento-Protein’s commercial feasibility. MSU was the pioneer in insect rearing methodology over 30 years ago, and remains one of the few Entomology programs worldwide to specialize in insect rearing. Research efforts began in April, 2007 with the first of three critical R & D stages.

Phase I Species Identification –
From an initial pool of 15 species candidates, the research team at MSU narrowed the field down to four species that met a detailed list of production criteria which included:
- Short life cycle
- High survival
- Gregarious
- Self-harvesting
- High fecundity
- Large body mass
- High dry protein to body mass ratio
- Adequate amino acid and fatty acid profiles
- Void of toxins or off-flavor components
Consumes diet of processing by-products

In May, 2007, initial results of the four species selected were obtained, and appear very promising. The results are expressed in Table 1a above in a comparison with fishmeal, as well as soybean and poultry meals.

Feed Acceptability and Off-flavor Testing -
Phase I research will conclude with feeding trials on juvenile hybrid striped bass at the Department of Wildlife and Fisheries at MSU. A standard 40% protein and 10% fat diet contains 20-23% fishmeal by dry
In the experimental diet, 100% of the fishmeal will be replaced with Ento-Protein of one or two of the insect species selected. Throughout a three week trial, diet acceptability will be evaluated. Upon its conclusion, an independent panel at MSU's Food Science Dept. will evaluate fish fed both control and experimental diets, for off-flavor.

**Diet Digestibility and Growth Trials** – Phase 2 research will include a three week growth trial and accompanying digestibility analyses. Growth trials will be extended for a period of two months to assess food conversion ratios of both control and experimental diets. As above, experimental diets will consist of full fishmeal replacement with Ento-Protein.

At this time, it is being considered whether a single source of Ento-Protein will be used, and/or a blend of two sources.

**ROAD TO COMMERCIAL DEVELOPMENT** Once the research has provided sufficient data to support fish growth and health, Neptune is prepared to move toward commercial development. An initial site will be sourced based upon favorable economic and climate conditions. A design and engineering team is already being assembled to map out the first production facility of its kind in the world.

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**Table 1a. Limited amino acid comparison of Ento-protein™ vs Fishmeal (as % of sample)**

<table>
<thead>
<tr>
<th></th>
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^ Analysis courtesy of Zeigler Bros.
**INITIAL INSECT COMPARISON TO FISHMEAL**

Table 2, below, compares an analysis of the four selected insect species with three varieties of fishmeal in a nutritional profile. The preliminary results of these analyses were very encouraging. Crude protein levels, fatty acids, and limiting essential amino acids were very comparable with fishmeal.

Crude protein was highest in Species A, which was most comparable to fishmeal. In terms of limiting essential amino acids, all four insect species compared very well in Arginine levels.

*Table 2. Comparison of the nutritional characteristics of selected insect species with common fish meals.*

<table>
<thead>
<tr>
<th>Species</th>
<th>Ash (A, %)</th>
<th>Minerals (M, %)</th>
<th>Lipids</th>
<th>Crude Protein (CP, %)</th>
<th>Amino Acids (AA, % PR)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>P</td>
<td>Total (L, %)</td>
<td>Linoleic (% L)</td>
<td>Arg</td>
</tr>
<tr>
<td>A</td>
<td>4.7(0.2)</td>
<td>0.2(0.0)</td>
<td>0.9 (0.0)</td>
<td>21(1) 34(-)</td>
<td>66(1)a</td>
</tr>
<tr>
<td>B</td>
<td>3.1(0.2)</td>
<td>0.06(-)</td>
<td>0.7(-)</td>
<td>34(2) 29(-)</td>
<td>49(1)</td>
</tr>
<tr>
<td>C</td>
<td>16(1)</td>
<td>5.2(0.2)</td>
<td>1.2(0.3)</td>
<td>32(3) 3.3(-)</td>
<td>43(1)</td>
</tr>
<tr>
<td>D</td>
<td>2.3(0.5)</td>
<td>0.04(-)</td>
<td>0.4(-)</td>
<td>57(2) 6.0(-)</td>
<td>36(2)</td>
</tr>
<tr>
<td>Menhaden</td>
<td>20(-)</td>
<td>5.7(-)</td>
<td>3.3(-)</td>
<td>10.2(-) 1.1(-)</td>
<td>68(-)</td>
</tr>
<tr>
<td>Herring</td>
<td>----c</td>
<td>2.6(-)</td>
<td>1.9(-)</td>
<td>9.9(-) 1.5(-)</td>
<td>73(-)</td>
</tr>
<tr>
<td>Anchovy</td>
<td>17(-)</td>
<td>4.3(-)</td>
<td>2.8(-)</td>
<td>8.6(-) 3.4(-)</td>
<td>70(-)</td>
</tr>
</tbody>
</table>

All entries are Mean(SEM) with N = 1-4 based on dry weights; SEM missing for N = 1.

aBold format: 0.75·MIN[fish meals] ≤ Mean ≤ 1.25·MAX[fish meals].
Lysine, Cystine, and Methionine levels were slightly lower than fishmeal, however were well within a range that could provide a high growth diet. The actual feeding trials will provide the most useful data as to the growth potential of the Ento-Protein based diets, as lab analyses do not take into consideration the synergistic effect of the diet, as well as the combination of elements and there overall affect on growth. Although Methionine levels are thought to be most limiting, this has not always proven to be the case in fish diets.

**KEYS TO SUCCESS**
Developing a new, revolutionary product involves many important steps. The thorough completion of research and analysis of data is critical to the success of commercial operations. Identification of potential bottlenecks and anticipated solutions should be mapped and included in the business development strategy. Clearly the economics of mass insect production will play a major role in the commercial viability. Utilizing low-cost land, labor, and feed will be key components. As well, technology and automation of facilities to reduce manpower and increase production efficiency will inevitably influence cost.

**BENEFITS TO THE AQUACULTURE INDUSTRY**
As an industry, we must react now to head off a significant bottleneck in projected growth and market competitiveness. Sustainability of feed is critical to allowing unhindered growth of our industry, as well as to protect and nourish our world fisheries stocks. All-natural and organic foods are producing 20%+ growth per year in the food industry.
A more and more countries come on-line with Organic standards and certification, the aquaculture industry should see a genuine growth spurt. Once again, the use of sustainable, high quality, commercially produced protein that can be certified organic will be critical to allowing farmed seafood to compete in this market.

The broad diversity and body composition within the class of insects should allow dietary recipes to be created to generate species specific diets. It is anticipated that Ento-Protein will initially provide a necessary solution to sustainable, all-natural, and organic based fish and animal production. As the production process reaches full stride globally, it may provide a high quality protein meal for fish, livestock and human diets.

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This article is based on a presentation by Ernest D. Papadoyianis, President and co-founder of Neptune Industries, Inc. at ‘Aquafeed Horizons’, Utrecht, the Netherlands (May 9-10, 2007), an Aquafeed.com Conference. Information on Aquafeed Horizons Asia, the next in this series of conferences can be found at: www.aquafeed.info. For more about Neptune Industries, visit their website. Mr. Papadoyianis may be contacted by email.
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Organic Aquafeeds - Ingredients and Ideals

Achieving truly sustainable and nutritionally complete feeds while maintaining economic viability is an ongoing challenge for the aquaculture industry and one in which the organic movement hopes to play a key role.

By Peter Bridson, Soil Association

Organic certification companies first began developing aquaculture standards in the late 1980s and began certifying fish in the mid 1990s. The organic movement as we understand it now had been established some time earlier (in the 1940s in the case of the Soil Association), and had developed its principles and philosophies purely on terrestrial agriculture. The move into aquatic farming therefore raised a number of issues, one of which was how to feed farmed fish in a way that satisfies these principles and philosophies.

In order to understand the formulation of organic aquafeeds, this article outlines the organic principles and standards that define them, and describes how these principles are put into practice with the key ingredients.

**ORGANIC PRINCIPLES**

The International Federation of Organic Agriculture Movements (IFOAM) has established the over-arching principles of the organic movement - the IFOAM Basic Principles. Under this umbrella, individual certification companies such as the Soil Association define their own working principles for agriculture and aquaculture.

There are four IFOAM basic principles, Health, Ecology, Fairness and Care. The summary line of each principle is below.

- **Health** - Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.
- **Ecology** - Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.
- **Fairness** - Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities.
- **Care** - Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations.

"...a number of pheromones and chemical cues can induce increased feeding activity in a range of freshwater and marine fish species.”

(the full text is available from www.ifoam.org).

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and the environment. Although still based on agriculture, they describe a holistic approach to the production of healthy farmed food, working with (rather than dominating) nature, minimizing environmental impacts and managing the operation in an ethical and socially responsible manner. This approach can equally be applied to aquaculture. These principles are put into practice through the organic standards which detail what must be done by organic producers and processors. For producers of organic aquafeeds, they define which are acceptable ingredients.

PUTTING PRINCIPLE INTO PRACTICE – KEY INGREDIENTS

Some species of organic fish such as tilapia, carp and potentially shrimp can (if grown at low stocking densities in extensive systems) be fed on food cultured within the pond itself or on relatively simple supplemental feeds. Ingredients for vegetable-based feeds simply require the use of certified organic ingredients. However, the bulk of organic fish presently being farmed are carnivorous - salmon, trout, cod, and seabass and these typically require the use of feeds with high levels of fishmeal and oil.

FISHMEAL AND OIL

In principle, the use of ingredients such as fishmeal and oil from non-food grade fisheries - a theoretically renewable resource - should be acceptable, but clearly the main problem with this is firstly finding a sustainable source and secondly, being able to prove it as such. The second factor - being able to prove sustainability - is becoming increasingly important. Organic certifiers take a variety of approaches to this problem. Some rely on the FAO’s Code of Conduct for Responsible Fisheries, but most concentrate on the use of fishmeal and oil made from the filleting wastes of fish already caught for human consumption. There has also been mention of the possible use by some organic certifiers of by-catch wastes, but this is a controversial subject, and as far as we are aware this source is not currently being used. The Soil Association’s standard for these ingredients is as follows:

You must use aquatic ingredients:
- of organic origin, or failing that
- from wild marine resources that we recognize as independently certified as sustainable (such as by the Marine Stewardship Council), or failing that
- made from the by-products of wild
caught fish for human consumption
In the UK there are approximately 50,000 tonnes of fishmeal and 12,000 tonnes of fish oil produced annually from the wastes of fish caught and gutted/filleted for human consumption ... and this is more than enough to satisfy the current demand. There are also other sources available in Northern Europe.
However, these ingredients do have their problems. Ash content is higher, FCR will be slightly lower, and the quality of the meal can be lower because the trimmings are not handled as well as the fresh fish.
We also want to concentrate on local supplies to avoid global transport and ‘food miles’, but the contaminant levels are higher in the North Atlantic. Fisheries are seasonal, with peaks of herring and mackerel wastes in summer and winter, and a relatively stable supply of white fish year-round.

To achieve this, we have established a unique partnership with the Marine Stewardship Council, sustainable seafood company Aquascot and the UK retailer Waitrose with the aim of achieving this goal by 2010. With a focus on North Atlantic fisheries to reduce transport, this is a significant challenge, but we are making good progress.

ENVIRONMENTAL CONTAMINANTS
The focus on local North Atlantic sources of fishmeal and oil puts us at risk of higher levels of environmental contaminants.
The available data shows that there are no significant differences between organic and non-organic fish, and levels in the environment are dropping relatively rapidly, but we would still like to make further reductions. We have worked with the feed companies to develop alternatives and have examined the techniques available for cleaning the oils. Even though the concerns over these contaminants are reducing, by using a combination of available methods we hope to reduce the levels significantly in the near future.

PIGMENTATION
Pigmentation of farmed salmon is another controversial area, but one for which the organic movements requirements are clear - organic feeds must use natural, that is non-synthetic, sources. Again the approach taken by different certifiers varies. The Soil Association considers that the fish should only be given enough pigmentation to satisfy their physiological requirements, but no more just to satisfy consumer expectations of brightly colored salmon.
We achieve this by only allowing the use of crustacean meals (made again from the processing wastes from human consumption fisheries) which are able to provide sufficient pigmentation. These meals are
impractical to use at high enough inclusion levels in the feed to give the darker pigmentation. Phaffia yeast is the main alternative, and is used by all the other organic certifiers (and in Soil Association brood stock feeds). Microalgal pigments are also a potential source of natural pigments, but difficulties in growing them organically prevent their use at present.

**VEGETABLE INGREDIENTS**
Replacement of fishmeal and oil with vegetable alternatives offers some potential advantages, including reducing the amount of marine resources used and lowering contaminants levels, but their production also has a significant environmental impact which must be taken into account. The use of vegetable ingredients is now widespread in salmon farming (although not in Scotland), but there has been resistance from organic retailers who are concerned about changes in the nutritional profile of the fish, and potential welfare implications from high substitutions levels of certain vegetable ingredients. In reality, there are already vegetable ingredients used in organic feeds. Organic wheat flour is used primarily as a source of starch for pellet binding, and soy meal may be used in some feeds. Substitution of vegetable oils is not being done at present, although the use of full fat soy meal will supply part of the fish’s energy requirements from the oils contained within them.

**ANTIOXIDANTS**
Again the emphasis is on natural non-synthetic alternatives to the widespread use of synthetic chemicals such as ethoxyquin, BHT and BHA. There are a variety of natural products now available using ingredients such as vitamin E tocopherols, vitamin C ascorbates, gallic acids and herb extracts. These can be formulated into liquids or powders and can be fat soluble or combined with natural emulsifiers if necessary. The use of synthetic antioxidants is being increasingly restricted by organic certifiers - the Soil Association has set a deadline of July 2007 after which only natural products will be permitted.

**FUTURE DIRECTIONS**
The intense focus on the sustainability of all types of seafood is likely to continue, and there are real concerns for the ability of the aquaculture industry to meet its future requirements for fishmeal and oil. We will continue to strive for independently certified sources of marine ingredients, but are keen to find alternatives. Terrestrial farmers are able to grow their own animal feeds - ideally fertilized by manure from their own livestock, and this is a
possibility for aquatic farmers too. The number of aquatic species suitable for culture as food items seems relatively limited, but it should be possible to supply a proportion of the fish’s feed requirements in this way. The quantities supplied may be small at first, but it is important to begin the development process. Aquatic feed ingredients are already diversifying and are likely to continue to do so as widespread research continues, but the global implications of climate change and the declining availability of mineral oil could potentially have a dramatic effect on this process. It is becoming increasingly important that these factors are taken into account.

The Soil Association is particularly concerned about how current farming methods are contributing to these problems and how they will affect our food production and supply networks in the future. This will undoubtedly have a considerable impact on aquatic feeds and their ingredients, perhaps in the near future - we are already starting to see the signs of this taking place - and we must develop more sustainable approaches to aquafeeds.

The principles of organic farming dictate the overall approach to feeding organic farmed animals. By using locally sourced waste products from fish already caught for human consumption and natural ingredients where possible, a relatively low impact is made on the environment.

About the author:

Peter Bridson has managed the Soil Association’s Aquaculture Development Programme since January 2005; he is currently responsible for standards development and research into the key aspects of organic fish farming. He is based in Edinburgh in the UK.

This article is based on a presentation by Peter Bridson at ‘Aquafeed Horizons’, Utrecht, the Netherlands (May 9-10, 2007), an Aquafeed.com Conference. For more about the Soil Association, visit their website. Peter Bridson may be contacted for further information by email.
WHAT makes the difference?
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INGREDIENT FORMULATION AND EXTRUSION PROCESSING PARAMETERS INTERFERE WITH NUTRITIONAL AND PHYSICAL QUALITY OF AQUA FEEDS
PART 1.

AKVAFORSK and Aquaculture Protein Centre (APC) studied interactions between extrusion processing parameters and ingredient composition on nutritional and physical quality of the feed for fish. This article discusses some of the research carried out by AKVAFORSK and APC concerning effects of extrusion on nutritional and physical quality of the feed.

By Mette Sørensen, AKVAFORSK, Institute of Aquaculture Research AS, 1432 Ås, Norway; Aquaculture Protein Centre, CoE, 1432 Ås, Norway.

EXTRUSION PARAMETERS AND NUTRITIONAL VALUE OF THE FEED

Feed mash undergoes significant changes during processing as it is heated, kneaded and sheared, suggesting that extrusion is not neutral to the nutritive value of the feed. A temperature higher than 100°C is needed in order to achieve expansion of the feed as it leaves the die. Extrusion temperature is usually a targeted value obtained through steam added in the pre-conditioner, dissipation of mechanical energy from heated surfaces such as barrel and screw surface, or generated by shear forces between wall and material and screw and material. Thus, heat generation is affected both by the choice of hardware and processing variables during the feed production.

“Elevated extrusion temperature may improve nutritional value”

Raising the temperature up to 90-95°C may occur in the pre-conditioner as steam and water is added in order to warm up and soften the ingredients. As the feed mash enters the extruder, further heating in the extruder descends from mechanical dissipation of energy from heated surfaces, or from steam injected directly into the barrel. The time during which feed mash is exposed to heating during processing (pre-conditioning and extrusion) is normally less than five minutes. Effects of extrusion temperature on digestibility and utilization of the diets by rainbow trout were examined in two different experiments. In the first experiment a fishmeal-based diet was extruded with a twin-screw extruder at three temperatures (100, 125 and 150°C) on each of two production days. In the second experiment, another fishmeal-based diet was extruded using a single screw extruder at two temperatures (100 and 140°C). The two studies showed that extrusion processing with temperatures in the range
from 100 to 150°C did not affect digestibility of protein, individual amino acids or energy. Similarly, feed conversion and net accumulation efficiency (retention) of protein and energy were not significantly different in trout fed diets extruded at 100 and 140°C. The growth rate was improved at the highest extrusion temperature in another study. In line with these results, research carried out this year found no significant effect of extrusion temperature on apparent digestibility coefficients of protein, organic matter, lipid, energy or carbohydrate in diets containing soybean meal for rainbow trout. Increased retention time in the extruder negatively affected feed intake and weight gain, whereas high temperature (127°C) resulted in improved FCR compared to the low temperature of 93°C. This indicates that feed extruded at the highest temperature was better utilized either due to improved availability or utilization of the nutrients or favorable feed structure.

“Elevated water content during extrusion contributes to higher nutritional quality”

Damage to proteins during heat processing is a function of temperature, time, moisture and the presence of reducing substances. High moisture content combined with short duration of exposure implies that extrusion may not be detrimental to the nutritional value. In general, low moisture content, especially in combination with severe heating, have shown to cause reduced digestibility of nearly all amino acids in fish meal, especially cysteine. Reduced digestibility of cysteine was also shown in rainbow trout when water addition to the extruder was restricted, compared to when the diet was produced at elevated moisture conditions. Cysteine reacts readily during heat treatment to form disulphide bonds between cysteine units. The reduction in cysteine digestibility in heat treated proteins has been explained by introduction of SS bonds, assumed to be resistant to proteolytic cleavage. Aslaksen et al (2006), however, did not find reduced digestibility of N in mink when the dietary content of disulfide bonds increased. In the latter experiment, mink were fed either a fish meal control (FM) or a diet where fish meal was partly replaced with either toasted soybean meal (SBM) or untoasted soy white flakes (WF). The diets were fed either as unextruded mash or extruded pellets. The dietary content of SS bonds in the fish meal diet was not affected by extrusion at 120°C and 28% moisture, whereas it was slightly increased by extrusion of diets containing soy ingredients. It has been suggested that other factors were more important for N digestibility than the content of disulfide bonds in the feeds. The improved performance of shrimps fed diets extruded at elevated moisture contents also emphasizes the significance of moisture during processing. From this it can be concluded that “dry” extrusion conditions should be avoided. In order to prevent losses of essential nutrients, a moisture content of 25-30% during wet extrusion of diets for fish and pets has been recommended.

“Effect of extrusion on trypsin inhibitor activity and nutrient digestibility”


Mild heat treatment during feed processing may for two reasons increase the nutritional value of protein-containing ingredients. Firstly, denaturation exposes sites for enzyme to attack and may thus make the protein more digestible. Secondly, heat labile proteinaceous anti-nutritive factors such as trypsin inhibitors and lectins may be destroyed.

The use of defatted, toasted soybean meal has been investigated as an alternative protein source to fish meal in diets for carnivorous fish. One main challenge when using soybean meals for fish is the content of indigestible components and anti-nutrients that are harmful to the fish. It has been shown that soybean meal in feed for Atlantic salmon causes inflammation-like reactions in the posterior intestine, which may be detrimental because of reduced immunological function of the intestine and reduced feed conversion efficiency.

Effect of extrusion on trypsin inhibitor activity and nutrient digestibility of diets based on fish meal, conventional defatted soybean meal (SBM) or untoasted defatted soybean meal (WF) were studied in experiments with mink and rainbow trout. In the mink trial the three diets were fed either as unextruded mash or extruded pellet. The intake of the unextruded WF diet was only one-third compared with the SBM and FM diets, most likely due to higher trypsin inhibitor content in this diet. In the mink experiment, a clear reduction in trypsin inhibitor activity was demonstrated in the extruded diet compared to the mash. Extrusion processing caused elevated digestibility of protein, total amino acids, fat and all individual amino acids with the WF diet, whereas no significant effect of extrusion on digestibility of these nutrients was shown for the FM and SBM diets. The authors suggested that extrusion processing was efficient to reduce trypsin inhibitor activity.

The use of the carnivorous terrestrial mink facilitated the comparison of meal mixtures with extruded feed. Previous experiments have unveiled high correlations in protein digestibility between mink and salmonids, thus mink studies are highly valuable as a model to predict protein digestibility with salmonids. The extruded diets were also evaluated in a digestibility experiment with rainbow trout. Fish fed the WF and SBM diets showed reduced feed intake, growth, fat and amino acid digestibility and poorer feed conversion compared to those fed the FM diet. Moreover, morphological changes in the distal intestine were clearly demonstrated.

The overall conclusion from these two experiments was that extrusion processing efficiently reduced trypsin inhibitor activity, and most likely other heat labile anti nutritive factors, without negative effects on nutrient digestibility.

“Physical quality of feed may interfere with nutritional value”

High physical quality of the feed pellet is necessary in order to minimize feed wastage and thereby maximizing feed intake and feed conversion.

The feed is subjected to different stresses that may induce fines during transportation in the processing line during manufacturing, during transportation to the fish farmer, and finally in the feeding devices. The pellet must be durable and remain in one piece until eaten by the fish, since dust and small fractures of the feed are not ingested and will result in poor feed conversion ratio. On the other hand, fish do not physically disrupt the feed in the oral cavity but gulp the pray whole.
If the feed is too hard, the pellet may stay intact during passage through the gastrointestinal tract, and the nutrients may be unavailable for enzymatic degradation. Research has shown that good physical quality of the feed is not necessarily equal to high feed utilization. Pacific white shrimp fed dry extruded diets were found to perform better on a diet with low starch gelatinization and water stability compared to shrimp on diets with higher gelatinization and water stability. These results may be explained by higher bio-availability of the nutrients in the feeds with the lowest technical quality. Recent research indicated that there is a strong connection between pellet water stability and degradation pattern of feed particles in the gastrointestinal tract of rainbow trout. Feed with low water stability caused separation and accumulation of dietary oil in the stomach that may have resulted in oil belching and reduced lipid digestibility.

About the author:

Dr. Sørensen is a research scientist at AKVAFORSK Institute of Aquaculture Research, a member of Aquaculture Protein Centre and assistant professor at University of Life Sciences, Norway, where she obtained her doctorate in fish nutrition and feed technology. This article is based on a presentation by Dr. Sørensen at ‘Aquafeed Horizons’, Utrecht, the Netherlands (May 9-10, 2007), an Aquafeed.com Conference. Part 2 of this article will be published next month; it will include a link to the full paper, including references.
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Happier days are coming for pigs, thanks to a major breakthrough developed by two Israeli scientists. Using a new patented additive, pigs that are grown in confined conditions, will be happier pigs, as they will breathe cleaner air, smell less foul odours and as a result, gain more weight. Pig welfare and surrounding environmental conditions will improve substantially thanks to the introduction of Cycle-G, the first dedicated, environmentally friendly formulation that will also improve pig production profitability.

A recent UN - FAO publication indicated that the livestock sector emerges as one of the top, and most significant contributors to the most serious environmental problems. Furthermore global production of meat is projected to more than double from now to the year 2050, driven by population growth and rising incomes. The continuing structural change in pig production towards further industrialization of livestock production is likely to make it a major contributor to global pollution.

"In view of global price increases of animal feeds and the urgent need to mitigate livestock damage to the environment, the introduction of Cycle-G, presents a novel and sustainable opportunity for global pig producers to comply with growing environmental challenges and improve production profitability" said Novagon Ltd. Founder and Chairman, Mr. Shai Schechter, who holds Cycle-G IP, production and marketing rights.

Pig production is an important economical factor in many countries. However the need to comply with environmentally standards, while increasing net profitability is a great challenge.

Following extensive research and in-situ tests in an experimental pig farm in the Netherlands, results indicate that Cycle-G is a major scientific breakthrough which promises growth potential for the global pig industry while reducing serious environmental pollutants and nuisance. Cycle-G has been shown to reduce ammonia emissions by nearly 50%, odor emissions by 29%, improve animal welfare conditions and reduce pig production costs by US $ 10.35 (per slaughtered pig), all contributing to higher production and profitability.

The company has most recently started discussion with potential global strategic and financial partners to cooperate in the future global commercialization of the additive.

"The ultimate objective is to attain a leading global position as supplier of animal eco-security systems, in a rapidly emerging new multi-billion dollar market, meeting the growing challenges for sustainable pig production while enhancing pig-industry economic competitiveness and profitability" added Schechter.

For Further information contact Shai Schechter: info@novagon.com.
Indian Immunologicals Limited (IIL), a wholly owned subsidiary of the National Dairy Development Board (NDDB) has made its new foray into the animal feed segment by launching a range of technological innovations in the field of dairy nutrition. These are Calsagar (a technologically superior animal feed supplement in pellet form, containing calcium, phosphorus and vitamin D3) for improved milk production, improved fat and SNF content in milk; Garbhamin Bolus (another innovation containing essential trace minerals in chelated form and coated vitamins) for superior reproductive performance, and Goumix, the first customized mineral supplement in the country for livestock based on regional mineral mapping carried out by NDDB.

This is in line with IIL’s mission to provide technologically superior health care products and feed supplements to the dairy farmers at affordable prices.

The cost of feeding contributes nearly 60% of the cost of milk production. The biggest challenge that dairy farmers in India face is the availability and affordability of quality fodder and feeds. Most feed ingredients locally available are deficient in one or more nutrients which results in loss of milk production debility, impaired growth and poor reproduction etc.

In order to supplement these essential nutrients and to enhance production, dairy farmers in India supplement the cattle feed with different types of tonics and vitamin / mineral premixes. However, most of these feed supplements do not meet the nutrient requirements of animals. The most commonly used feed supplement is calcium tonic, as it is essential for milk production and bone formation. Calcium supplementation in dairy farms is usually done through oral liquid suspensions through product similar to human preparations.

However, this is not only expensive and wasteful for the dairy farmers, but is also poorly absorbed in the animal body. IIL has recognized this special need of dairy animals and has through its own research and backing of NDDB, formulated a special calcium and phosphorus feed supplement. This supplement, named as Calsagar is superior in performance, convenient to use and quite affordable compared to various preparations in the market. The efficacy of Calsagar in enhancing milk production and improving health and conception rate has been proven through rigorous trials in leading veterinary colleges.

The other two other nutraceuticals launched by IIL, Garbhamin and Goumix are also innovations specially developed to meet specific needs of dairy farmers. Besides this, IIL plans to launch more feed supplements such as By-Pass Fat and By-Pass Protein, which are technological innovations in the field of animal nutrition, and are considered to be vastly superior to conventional oil cakes and locally available fat supplements.

The feed supplements market for dairy animals is estimated to be nearly Rs. 200 Cr out of the Rs. 1400 Cr animal health market and is dominated by multinational players.
The heavy rains that have swept across large portions of the British Isles this summer are bringing a significantly increased risk of mold and toxin contamination to grain farmers and feed manufacturers, according to agricultural specialists Agil.

In France, where similar rainfall occurred, there has been a surge in sales of toxin binders such as Sorbatox, which traps the mycotoxins. These mycotoxins are produced under damp conditions both in the standing crop and in storage.

Met Office figures for the U.K. have shown that recent months have been the wettest on record.

England and Wales have seen
the wettest May - July period since records began with around 390mm more than twice the national average. All regions have seen record rainfall and all except South East England, North West England and North Wales have seen over twice their average rainfall. The worst hit area is the Central England region which has seen 226 per cent of average rain.

“After a wet summer like this with poor harvest conditions, molds such as *Fusarium* and *Aspergillus* can be found on standing crops,” says Murray Hyden, managing director of Agil.

“If not treated these molds can seriously impact on yields, profits and animal health.” *Fusarium* is recognized in the field by the premature bleaching of infected spikelets and the production of orange spore-bearing structures called *sporodochia* at the base of the glumes. During wet weather, this is likely to take the form of white / pinkish, fluffy fungal growth on infected heads in the field.

The *Aspergillus* mold, along with *Fusarium*, is one of the main producers of mycotoxins, including Aflatoxin, a naturally occurring mycotoxin. The production of Aflatoxin also increases in wet summers and is helped by moderately high temperatures too. Fungal growth in standing crops result in a dull, grey appearance rather than the more typical bright golden colored fields at harvest.

“There are a number of options open to farmers to inhibit and combat mold and toxins,” explained Mr Hyden. **Mycostat** and other effective anti-mold inhibitors which are based on propionic, acetic and sorbic acid combined with their ammonium salts can prevent new mold colonizing and existing molds from growing and producing toxins in the stored grains.” 

“Working alongside these mold inhibitors, many farmers also use toxin binders such as **Sorbatox** which work very effectively in the aqueous environment of the animal intestine. These binders, which have a high level of aluminum silicate, provide a large number of sites within the mineral to attract and hold secure the particularly dangerous varieties of mycotoxins. These toxins are then excreted naturally without being absorbed into the intestinal tract and impacting on feed conversion and fertility”

### INNOVATIVE ASTAXANTHIN PRODUCT FROM DSM

Royal DSM N.V. has announced its newest innovation in carotenoids: CAROPHYLL Stay-Pink. This concept, adapted from nature, makes a generational step in existing carotenoid technologies. The DSM technology makes use of an improved structure to protect the astaxanthin molecule. Based on the need of today’s customer, the major concern for astaxanthin is its stability during the processing and storage of feed products in which it is incorporated.

With CAROPHYLL Stay-Pink, DSM has developed a breakthrough technology that addresses the issue of the processing stability of astaxanthin.

This unique approach leads to diminished losses during processing and storage.
Close consultation with customers made it clear that a significant innovation with this carotenoid was necessary to meet the market needs. Market pre-testing has resulted in very enthusiastic customers who recognize the product's potential to help address their needs for a more stable high quality product. DSM is currently in the process of having CAROPHYLL Stay-Pink registered in the EU as a sensory additive following the conditions of Regulation 1831/2003. A summary of the European application, which was published on 22 May 2007, can be found on the website of the European Food Safety Authority here. Registration of CAROPHYLL Stay-Pink in other countries is also progressing. The submissions to the various authorities have been very well met and timely approvals are expected. "With this innovation DSM once more demonstrates its strong commitment to the aquaculture market," states Jos Schneiders, President Animal Nutrition and Health. "With this second generation astaxanthin we help support DSM's goal to create value for our customers. It's a typical example of market-driven growth and innovation, one of the key pillars of DSM's strategy Vision 2010 - Building on Strengths."

Links: www.dsmnutritionalproducts.com
www.dsm.com

ANADA APPROVAL FOR FORMALIN

The Food and Drug Administration of the United States (FDA) has amended the animal drug regulations to reflect approval of an abbreviated new animal drug application (ANADA) filed by B.L. Mitchell, Inc. The ANADA provides for the use of Formicide-B (formalin), a generic copy of Parasite-S, sponsored by Western Chemical, Inc., in a water bath for the control of certain external parasites on finfish and shrimp and for the control of certain fungi on finfish eggs.

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The workshop is the third in the highly successful series of meetings organized by the aquafeed portal, quafeed.com, in association with Victam international.

The meeting will provide invaluable insights for service, ingredient and equipment suppliers, researchers, veterinarians and others whose business depends on understanding the needs of aquaculture and the possibilities offered by advances in aquafeed technology and formulation.

Sponsored by Wenger International, Inc. and supported by the Thai Department of Fisheries

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- Dr. Andrew Moore, Centre for Environment, Fisheries and Aquaculture Science, U.K.
- Dr. Peter Coutteau, Inve, Belgium
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Recent approvals for AQUAFLOR (florfenicol) for use in catfish and freshwater-reared salmonids have provided much-needed antimicrobial treatments for salmonid and catfish producers, according to Steve Sharon, Fish Culture Supervisor, Wyoming Game and Fish Department.

However, the Veterinary Feed Directive (VFD) drug classification for AQUAFLOR, from Schering-Plough Animal Health Corporation, mandated by the U.S. Food and Drug Administration (FDA) has also created some challenges to feed companies and growers, particularly when only small batches of medicated feed are required.

“Fortunately, the vast majority of prescribed VFDs typically deal in tons of feed shipped and can easily be filled directly by the feed company,” Sharon explains. “However, the requirement for a feed mill to receive a VFD directly from a veterinarian prior to shipment in a specific prescribed amount can be very problematic if the infected fish lot is small in number, or if the feed poundage prescribed does not fit within 40- to 50-pound increments that a feed company typically ships.”

For example, the first VFD order for the Wyoming Game and Fish Department involved bacterial coldwater disease in a very small, but extremely valuable, brood-recruitment lot of cutthroat trout. The entire 10-day treatment called for a total of 6 pounds of medicated feed. Since the prescribed amount was well below 50 pounds, the department could not receive feed directly from the mill.

Catfish fresh from the farms are ready for processing at the Heartland Catfish Processing plant in Itta Bena, MS. USDA Photo by: Ken Hammond.

40- or 50- pound increments
After consulting with FDA and the local feed company, the Wyoming Game and Fish Department established its own feed distributorship, which allows the state agency to receive medicated feed directly from the mill and then deliver it to its fish-culture facilities as ordered by a veterinarian through a VFD. Under this arrangement, either a company or a wildlife agency can receive fish feed in 40- or 50-pound increments as a feed distributor without the requirement of a VFD order. In turn, the feed distributor can maintain a feed inventory and distribute the exact prescribed amount to a fish-culture facility upon receiving a VFD.

According to Sharon, this arrangement has allowed them to fulfill small VFD orders, keep VFD feeds on hand for cyclical fish-health issues and deliver feed quickly to a fish-culture facility after receiving a VFD.
Develop an agreement
To become a feed distributor, a company or wildlife agency must notify FDA of its intent to become a feed distributorship for VFD feeds and must develop an agreement with a feed company to become a VFD feed distributor as regulated by federal law, Sharon says.
It also must establish the feed-distribution point at a location where fish are not reared. The distributor can then ship VFD-medicated feed to another feed distributorship without a VFD order. The distributor must maintain inventory control, original VFDs and supporting documentation for a minimum of 2 years.
As with any VFD drug, Sharon explains, it is extremely important to have a strong veterinarian-client-patient relationship to maintain an effective treatment protocol.
“The development of a feed distributorship provides an opportunity to allocate specific feed amounts in a short time frame that cannot always be accomplished by a feed mill,” he says.
“Also, the opportunity to network with other feed distributors to consolidate or utilize inventories can shorten delivery time if medicated feed is not readily available from a feed mill. A feed distributorship has enhanced our capacity to treat any given fish lot, regardless of its number, and has shortened response time on several treatments over the summer.”

Further information on VFD procedures and Aquafloror.

CAUTION: Federal law limits this drug to use under the professional supervision of a licensed veterinarian. Animal feed bearing or containing this Veterinary Feed Directive (VFD) drug shall be fed to animals only by or upon a lawful Veterinary Feed Directive issued by a licensed veterinarian in the course of the veterinarian's professional practice.
CFE has acquired the die manufacturing business from OSL Group Holdings Ltd. OSL Walden has been involved in die manufacture for more than twenty years and was the sole U.K. pellet mill die manufacturer. CFE, the Kerry based enterprise, has plants in Castleisland in Ireland, Haydock in the U.K. and Helmond in the Netherlands. This acquisition will consolidate CFE’s position as market leader in their sector in Ireland and the U.K. It will also provide dies for their Benelux operations. The purchase is part of a €2 million investment that will more than double the OSL die production business. CFE has in excess of four million tonnes on pelleting consumable contracts in Ireland and U.K.

The business will be transferred from Sheffield, England to CFE’s U.K. plant in Haydock, St. Helens. The transfer will happen over a three month period. CFE managing director, Con Lynch, says that the investment will make CFE more sustainable and give security of supply in this time of fluctuating steel prices and drilling capacity problems. “OSL die drilling has enjoyed strong growth over the past number of years and will benefit from the support and resources from a stronger player in the sector”, said OSL Group managing director, David Grey. All existing orders will be fulfilled in the normal manner and CFE is working hard with the OSL management team to effect a smooth transition.

As part of Perstorp’s ongoing effort to expand its Product Management and Sales Management divisions, Jean-François Herin has joined the company to strengthen its feed additive business in Central and Eastern Europe and the Middle East. He will also be responsible for expanding the business in Africa. Based in France Mr Herin is highly suited for the job. A Doctor in Veterinary Medicine, he has 21 years of experience in animal health and nutrition and has worked in Central and Eastern Europe, Africa and the Middle East for the last 14 years of his career. For nearly fifty years Perstorp has been involved in developing a range of highly effective feed additives to improve the performance of farm animals. Today, the range, quality and properties of the feed additives make a real difference in helping customers to become more competitive.
Aller Aqua invests in pea protein and aquafeed plants

Emsland-Aller Aqua GmbH, a 50/50 partnership between Danish fish feed producer, Aller Aqua, and German potato starch producer, Emsland-Stärke GmbH, has finalized the first step of a large investment in Germany: the construction of a pea protein factory.

The Aller Aqua Group will build its fourth fish feed factory on the same site. The company has plants in Denmark, Poland and Germany. It also took over the company Beeskow Fish feed in December 2006.

The German activities are managed from the Danish side by CEO and owner of Aller Aqua A/S, Hans Erik Bylling, and managing director of Aller Aqua Technology Aps., Henrik Halken.

“Aller Aqua is among the largest producers of quality feed for aquaculture in Scandinavia and Europe. We export to more than 35 countries worldwide. With this investment in Germany we are speeding up our growth ambitions in the group and will be prepared to meet future challenges and strategies”, he said.

Aller Aqua Technology was established in October 2006 with the purpose of being a development company to initiate new projects in the Aller Aqua Group.

“We are trying to find interesting and relevant possibilities all around the world”, Halken said.

“Aller Aqua has more than 40 years of experience in fish feed production and management of international companies. We want to use this knowledge in Aller Aqua Technology to establish new factories, license production and supply of raw materials to selected partners. We have already started one license production of fish feed abroad and are looking into establishment of new companies, where we can fulfill our strategy and objectives”.

GOOD POTENTIAL FOR HIGH PROTEIN PRODUCT

The reasons for starting the protein project in Germany are many.

“First of all, we have created a nice product with a protein content of 75-80% and with an excellent amino acid profile”, Halken explained.

“All anti-nutritional factors are removed in the production process we use. Therefore, from a technical and nutritional point of view we have a product with many application opportunities: fish feed, piglet-feed, pet food and so forth”.

Another reason Halken gave was the turmoil being experienced in the raw material markets these days.

“Prices are changing rapidly, some products are on allocation and so on. Therefore, we have to focus more on the raw material sup-
ply in the future. Pea protein is an ingredients to which feed producers could give further consideration”.
Halken sees projected growth in aquaculture of 8-10% and greater consumption of fish in the years to come as well as a focus on the sustainability of wild fisheries as all positive for aquaculture production and Aller Aqua’s companies.
“But again, this leads to a higher pressure on the raw materials and the availability of these”, he notes. “Estimates say that more than 60% of the fishmeal output by 2010 will be consumed in fish feed. This will lead to a focus on alternatives”.
“We have already contacts with a lot of potential clients, so that is a good start. It tells us that we have a good product and that our timing is good. These are two important factors to achieve success!”
“We have been producing pea protein this last month – and it looks promising”. The next step in the project is the establishment of a state of the art fish feed factory next to the protein factory in order to use the synergies in logistics, administration and so on.
Aller Aqua is currently negotiating with construction companies, extruder suppliers etc. “When all this is done and all permits are ready, we will start the construction”, Halken said.
“We feel very welcome in Germany in the area around Berlin, and we have an excellent cooperation with the authorities, who are very interested in getting this project realized; so hopefully we can also soon start the production of fish feed in Emsland-Aller Aqua GmbH”, Halken said, adding “by the way, when finished, our mill in Germany will be the only fish feed factory on German ground”.

Cost effective single-cell shrimp hatchery feed developed

Scientists at the Fisheries College and Research Institute (FCRI) in Tuticorin, India, have developed a single cell marine shrimp larval feed that they claim is 20 percent less expensive than artemia cysts and its manufacturing process simpler than that of microalgae cultures.
The Hindu newspaper reports that FCRI Dean, V. K. Venkataramani, said the soon to be commercialized feed, named ‘Marine Single Cell Detritus,’ (MSCD) was developed through a two-stage enzymatic and fermentative treatment of seaweeds.
In the first stage, the seaweeds were treated with an enzyme which led to the formation of single cell units.
The enzymatic digest was then treated with bacteria and yeast in the fermentative phase to form the product.
According to Dr Venkataramani, in addition to the economic advantages, trials show MSCD has bioremediation properties which control water quality.
"The 'probiotic' characteristics of the feed helps the fish develop infection resistance. The MSCD has 35 percent crude protein, making it nutritious and possible to be stored in room temperature for an year", the Hindu reports.
Training will be given to hatchery owners who are interested in its mass production.
Ethanol Byproducts Pelleting

Researchers have found a way to pellet DDGS, increasing its potential availability

One hundred percent of the ethanol industry by-product distiller’s dried grains with solubles (DDGS), can be pelleted without adding a binding agent - or anything else, according to U.S. Agricultural Research Service (ARS) scientists and cooperators. ARS agricultural engineer Kurt Rosentrater has turned DDGS from corn-based ethanol production into high-quality pellets using processing equipment at a commercial feed mill. And the heating used in pelleting did not harm the high-protein, low-starch nutrient content.

Rosentrater is at the ARS North Central Agricultural Research Laboratory, Brookings, S.D. He does this research with colleagues at ARS and at nearby South Dakota State University.

DDGS is the protein, fat, fiber, unconverted starch and ash left over after ethanol production.

Cattle feed is currently the primary outlet for distiller’s grain. But other livestock such as swine and poultry can also eat it. To date, there are no commercial DDGS pellets available for livestock, which limits the byproduct’s use in rangeland settings.

Rosentrater is experimenting with adding soy and corn flour to distiller’s grain to produce pelleted aquafeeds, to see how far he can reduce the fish meal—or if he can eliminate it entirely.

This pelleting work also promises to solve a growing problem of product deterioration—as well as hardening and caking problems during shipping and storage, which can clog the various chutes and bins that DDGS flows through. With an increasing supply of the byproduct, ethanol plants have to ship it greater distances to reach markets.

Fortifying Feed with Biodiesel Co-products

Biofuel research isn’t just a matter of finding the right type of biomass—corn grain, soybean oil, animal fat, wood or other material—and converting it into fuel. Scientists must also find environmentally and economically sound uses for the by-products of biofuel production. Agricultural Research Service (ARS) scientists Brian Kerr and William Dozier have done just that.

Current biodiesel supplies are often made from the triglycerides, or fat, found in soybean oil. But processing biodiesel from soybean oil also yields crude glycerin, also known as glycerol, which has a purity level of about 85 percent. It also contains small
amounts of salt, methanol and free fatty acids.
If glycerol is refined to 99 percent purity, it can be used in many products, including pharmaceuticals, foods, drinks, cosmetics and toiletries.

Kerr, Dozier and Iowa State University colleague Kristjan Bregendahl studied whether crude glycerin could be used to supplement the feed of laying hens, broilers and swine. They found that crude glycerin provided a supply of caloric energy that equaled or exceeded the caloric energy available in corn grain. Feeds containing up to 10 percent glycerin had little to no adverse effect on laying hen egg production or broiler body weight gain. Pig body weight gain, carcass composition and meat quality also showed little to no adverse change after equivalent levels of crude glycerin were added to their feed.

Safe levels for salt, methanol and free fatty acids in crude glycerin consumed by nonruminant livestock still need to be determined. But as corn grain ethanol production and conversion soar, corn grain supplies for livestock feed are decreasing. Using crude glycerin to supplement feed supplies could provide livestock producers with a readily available, inexpensive and energy-packed alternative to corn grain.

Kerr is an animal scientist at the ARS National Soil Tilth Laboratory, Ames, Iowa. Dozier is an animal scientist at the ARS Poultry Research Unit, Mississippi State, Miss. They presented their findings at the 68th annual Minnesota Nutrition Conference in Minneapolis, Minn. ARS is the U.S. Department of Agriculture’s chief scientific research agency.

Norwegian study investigates sensitivity of Atlantic salmon to endosulfan

The increasing use of plant ingredients in fish feeds can lead to exposure to higher levels of contaminants such as the pesticide endosulfan. NIFES is investigating the impact of endosulfan in feed on fish health. Few and small changes in blood parameters in fish that received 710 microgram endosulfan per kilo feed for 49 days indicated that Atlantic salmon tolerate high dietary endosulfan levels, says Dietrich Petri, scientist at the Seafood Safety research program at NIFES.

Endosulfan is an organochlorine pesticide that is used in agriculture. Adverse effects of endosulfan on humans as well as on mammals are well documented. Fish, in particular salmonids, seem to be very sensitive to waterborne endosulfan exposure, as seen after runoff from agricultural land or accidental discharge into rivers. However, information regarding the effects of oral exposure to fish is limited. The current EU maximum level (ML) for endosulfan in fish feed is considerably lower than in feed for terrestrial farm animals (5 vs. 100 microgram per kilo feed), possibly limiting the choice of plant products by the feed industry.
Feeding experiment with endosulfan
In an initial range finding study, Atlantic salmon pre-smolt (weighing about 50 gram) received diets that contained increasing concentrations of endosulfan (4, 50 or 710 microgram endosulfan per kilo feed) or a control diet for 49 days. General growth parameters, haematology and clinical chemistry in plasma were used to detect adverse effects on fish health.

Results from experiment
The feed concentrations of endosulfan did not result in clear clinical symptoms or clear adverse effects. Only minor and transient responses were noted in the highest dose group.
Condition factor, which gives information on the relationship between weight and length, was slightly but significantly reduced by day 49.
Certain hematological parameters (hemoglobin, hematocrit) were significantly increased in the highest exposure group on day 35, but had returned to levels similar to controls by day 49.
Elevated concentrations of a liver enzyme (ASAT) were detected in two fish in the highest dose group, but there was no significant difference among treatments. Similarly, the proportion of different white blood cells (leucogram) was not statistically affected by treatment, while lymphocytes of two fish in the highest group showed irregularities in the cell nuclei.

How much endosulfan is tolerated?
Few and small changes in blood parameters in fish that received 710 microgram endosulfan per kilo feed for 49 days indicated that Atlantic salmon tolerate high dietary endosulfan levels.
Further analyses of fish from this study are being conducted and will give more detailed information on the impact of endosulfan on fish health.

Aberdeen scientist receives major animal nutrition award
Dr. John Wallace, a senior scientist at Aberdeen’s Rowett Research Institute, has been awarded the DSM Nutrition Award for 2007 in recognition of his pioneering research in animal nutrition. The judging committee made special mention of his recent pioneering research to develop natural plant-based products as supplements for animal feeds. His research career has focused on the mysterious world of the rumen.
"Initially my research looked at how feed additives such as yeast worked, and I was also interested to discover the mechanism of action of antibiotics, which at one point were widely used in animal nutrition to promote growth. We found that these additives have an effect on the metabolism of the rumen bugs, and can have a large impact on the how the animals grow, and their productivity".
Dr Wallace has coordinated two large European projects examining plants, plant extracts and other natural materials for their potential as safe alternatives to antimicrobials.
"We have been successful in identifying plant materials that can improve nitrogen retention in ruminants, which basically means that the animals grow better and their urine is less polluting. In addition, we have found a type of chrysanthemum which helps to improve the fat composition of milk. The current project, called REPLACE, is conducting some animal trials on the most promising plant materials collected during the first project. Early results from some of the trials with early-weaned pigs look very interesting as the plant extracts seemed to help prevent the diarrhea which these piglets are very prone to suffer from," said Dr Wallace.
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For more information see the IFFO website

November 1-3, 2007
AFIA Equipment Manufacturers Conference - Phoenix, AZ, USA
AFIA's Equipment Manufacturers Conference is an educational experience designed to address many issues pertinent to today’s equipment designers, builders and installers who serve the feed, pet food and grain industries.
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November 11-13, 2007
Soya & Oilseed Summit 2007 - Chicago, IL, USA
Soytech's conference "Innovations in Food and Energy", will bring together leaders from the global food and energy industries to explore key issues and opportunities emerging in the rapidly changing global marketplace for food and fuel, at a time when both are competing for similar resources. Details

January 23-25, 2008
AFIA International Feed Expo 2008 - Georgia World Congress Center, Atlanta, GA, USA
Attendee Prospectus
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March 5-7, 2008
Victam Asia 2008 - Bangkok, Thailand
South East Asia's premier exhibition and conferences for the animal & aquatic feed, rice & tapioca production industries. Details

March 5-7, 2008
Feed Ingredients & Additives Asia Pacific - 2008 - Bangkok, Thailand
FIAAP 2008 is the only specialist trade show that offers complete coverage of the Asian/Pacific markets for ingredients and additives used in the production of animal feeds, pet-food and aquafeed. Details

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