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  A new salmon feed ingredient that could revolutionize the global salmon farming industry

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  PescaMaris, Ecuador, credits the strategic use of fish peptide/nucleotide isolates as a key aspect for the improvement in their operations
Most formulators and nutritionists are familiar with Linear Programming (LP) which is very widely used to obtain least cost formulae when mixing raw materials to meet specified nutrient profiles. The optimal formulae, which are normally displayed in three or more decimal places, may be impractical to use in the mill or factory unless these values are rounded to account for the accuracy of the weighing equipment. The weighing accuracy is typically defined using two values, these being the Minimum Weighing Quantity (MWQ) and Rounding Factor (RF). The MWQ is the lowest amount that the weigh scale can dispense, taking into account in-flight materials etc. The RF defines the incremental weights that the weigher is able to dispense accurately. For example, an RF value of 10 kg would mean that incremental weights of 0, 10, 20, 30, 40kg. only, can be dispensed so the formula needs to be adapted to use one of these amounts.

In the (fictitious) formula to the left, the inclusion of Ingredient 3 is 34.885669% which amounts to 348.857 kg in a one tonne batch. If MWQ = 10 and the RF = 10, these operational constraints means that the mill can dispense accurately either 340 or 350 kg but not 348.857 kg.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
<th>Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totals</td>
<td>100.00</td>
<td>1000.00</td>
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<tr>
<td>Ingredient 1</td>
<td>4.708019</td>
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<td>105.082</td>
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<tr>
<td>Ingredient 3</td>
<td>34.885669</td>
<td>348.857</td>
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<tr>
<td>Ingredient 4</td>
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<tr>
<td>Ingredient 5</td>
<td>10.00</td>
<td>100.00</td>
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<td>Ingredient 6</td>
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<td>Ingredient 7</td>
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<td>32.842</td>
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<tr>
<td>Salt 1.22</td>
<td>7443</td>
<td>12.274</td>
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<tr>
<td>Liquid Fat</td>
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<td>31.865</td>
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<tr>
<td>Premix supplement</td>
<td>0.2</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Fig 1: Example of Optimised Formula

**TRADITIONAL METHODS OF Rounding**

Linear Programming works very well when the constraints are “continuous” or allowed mathematically to vary between the upper and lower constraints (or bounds) without any limitations. Given the number of decimal places to which modern computers operate, a solution like the one in Fig 1 is obtained.
On the other hand Linear Programming does not deal efficiently with problems where the constraints between the upper and lower bounds are set in fixed increments or integers. Historically, obtaining a rounded solution directly from the optimiser has not been practical so the solution is approximated in one of two ways.

1. **Apply the MWQ/RF after the optimisation.** Adjusting the formula after optimisation usually means some of the upper and lower limits are not satisfied. In the case of a large ingredient such as Ingredient 3 in our example, the difference between the actual value and the bounds is likely to be small and is probably within the acceptable deviation. The problem potentially is with the “smaller” raw material such as SALT. If the MWQ is 20 and the RF 10, then this inclusion would most likely be rounded out altogether, or alternatively it could be 20kg if the program is set to round up. Either result may cause the nutrients sodium and chlorine to fall significantly outside both the upper and lower bounds. Safeguards can be built in to prevent key minor ingredients being rounded out altogether, but formulators usually check the result manually before authorising the formula for the mill.

2. **Iteration.** After a feasible solution has been found, using the normal method, the MWQ/RF are applied to the result and the changes re-optimised. If a feasible solution is found this is fine, otherwise the MWQ/RF are applied slightly differently and the solution re-optimised again, and so on, going around this loop a fixed number of times. The more raw materials that use MWQ/RF in the formula the more difficult it is to obtain a solution. Even when a solution is found this may now deviate substantially from least cost one as this method takes no account of ingredient and nutrient sensitivities. Such solutions may be much more expensive than they need to be.
**MIXED INTEGER OPTIMISATION (MIO)**

A more appropriate solution is obtained when the formulation software uses the MWQ and RF directly within the Formulation Solver thus obtaining the least cost solution that complies with all the Upper and Lower Constraints. This type of problem is non-linear and requires Integer Optimisation in order to solve it.

A combination of Linear Programming and Integer Optimisation type constraints can be solved using Mixed Integer Optimisation. There have been substantial advances in techniques and algorithm development over the past decade and this technique has wide applications throughout industry.

In the case of single formula optimisation the algorithm is relatively straightforward; only the cost and availability of raw materials and not the quantities are taken into account. A much more complex scenario arises where multiple formulae for a given production period are optimised together as one problem, taking into account the quantities to be produced and the raw material tonnages available. These raw materials may be in short supply or may be in surplus, and must be allocated by the program to provide the cheapest overall solution. The specialised optimisation algorithm required to solve this complex problem is now implemented by Format.

The benefit of using the new technique is that the formulae produced are capable of being manufactured accurately without manual intervention and without subjecting them to a rounding process which introduces unintended violation of the specification. Clearly the formula produced using this technique will be slightly more expensive than the purely linear version which is un-weighable in its

<table>
<thead>
<tr>
<th>Solution method</th>
<th>Formula Cost</th>
<th>Nutrient violations</th>
<th>Violation range %</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIO 111.</td>
<td>007</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>LP 110.</td>
<td>555</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>LP then rounded 50/50</td>
<td>110.086</td>
<td>6</td>
<td>+14.36 to -6.18</td>
</tr>
<tr>
<td>LP then rounded UP</td>
<td>110.866</td>
<td>6</td>
<td>+16.64 to -0.96</td>
</tr>
<tr>
<td>LP then rounded DOWN</td>
<td>110.227</td>
<td>6</td>
<td>-0.36 to -13.28</td>
</tr>
<tr>
<td>LP with manual intervention to</td>
<td>111.332</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ensure constraints satisfied</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
initial form. However, the result from this technique may very well be less expensive than the alternative derived from pre-determining some ingredient constraints in the specification so that the resulting formula can be weighed and meets the nutritional specification.

Example: Optimising an example specification with 21 nutrient constraints produces a solution using 13 ingredients.

The raw LP solution produces the cheapest correct formula, but contains a number of ingredients which cannot be weighed accurately. Applying automatic rounding to the LP solution produces alternative formulae; two of these are less expensive and one is more expensive, however all 3 of the rounded solutions violate the specified nutrient constraints and for some nutrients the violation is by more than 15%. Manipulating the LP solution so that the nutrient constraints are satisfied and the ingredients can be accurately weighed gives a solution which costs 111.332. This is the most expensive of all the formula reported in the table above. By contrast, the MIO solution, which can be weighed accurately, and which satisfies the constraints, costs 111.007, a saving of 0.325 or almost 0.3%

Format has implemented a Mixed Integer Algorithm into its award-winning Integra-Mix® software. Integra-Mix® is able to solve this complex question, optimising multiple formulae with multiple subcomponents, with constraints on the availability of raw materials, taking into account the minimum weighing quantities and rounding factors of the individual ingredients. This is a significant advance in formulation techniques and will bring further benefits in the businesses that use this software.

For more information please contact Format or visit www.formatinternational.com
Once found primarily at specialty retailers like Whole Foods Market, organic food has grown 5-20 percent each year over the last decade in the United States, Europe and Japan. Today, organic food is available at major retailers around the world, including Wal-Mart, Carrefour, Marks & Spencer, and Sainsbury’s, with studies showing consumers are willing to pay a 20- to 100-percent premium for organic products that are environmentally friendly, contain natural ingredients and colors, and are made from renewable sources.

While organic certification for aquaculture has been in existence in Europe since the mid-'90s, when Naturland (Germany) and the Soil Association (U.K.) launched organic standards for farm-raised salmon and trout (FAO, 2002), the European Union recently consolidated these organic certification bodies and others under its own organic production logo (EU, March 2010) to simplify organic labeling efforts and address growing consumer demand for organic products.

With the rise of consumer interest in organic products and global demand for seafood exceeding supply, many fisheries, fish producers and feed manufacturers have begun adopting more sustainable practices, reducing overall fish meal content and purchasing naturally sourced feed ingredients instead of synthetic, non-renewable sources and have been able to command premium product prices in countries and markets where natural and organic standards exist.

THE ROLE OF ASTAXANTHIN IN AQUACULTURE

Salmon species represent the largest volume and contribute the most value to the global aquaculture industry, with flesh color and filet freshness the two most important consumer purchasing criteria (Sigurgisladottir, et al 1997). Since salmon cannot synthesize the carotenoid astaxanthin, which is responsible for the red, orange and yellow hues in fish and crustaceans, it must be consumed as part of their diet from wild sources such as krill or as a supplemented feed ingredient (Bjerkeng, B. and Berge, G.M., 2000).
As the leading provider of naturally sourced astaxanthin for the aquaculture industry for more than a decade, Naturxan works with feed manufacturers, animal nutrition specialists and salmon and trout farmers to help them achieve the signature pink color of wild salmon without the use of petrochemicals or recombinant DNA modification to the production organism.

Aquasta by Naturxan is made from renewable ingredients, such as corn sugar, and satisfies the health and purchasing preferences of consumers and retailers that prefer naturally derived aquaculture products. Aquasta is accepted by key organic programs around the world, including Naturland, BioSuisse, DEBIO, KRAV, DEFRA, POSA, the Organic Food Federation, the Irish Organic Farmers and Growers Association and Agriculture Biologique among others.

AQUASTA IN THE FEED STUDIES

For technical buyers considering the use of a natural pigment source in the composition of their feed, Aquasta has been proven as effective as synthetic astaxanthin in flesh pigmentation and color expression through tests of various feed product extrusion processes, production timelines, storage temperatures, and in commercial field trials involving fresh, frozen and smoked fish such as Atlantic salmon, Coho salmon and Rainbow trout (Storebakken, 1998).

Aquasta is easily blended to homogeneity with other raw feed materials on a commercial scale, which has been confirmed by an HPLC analysis of 10 samples taken in triplicate.

Naturxan conducted a stability study during the feed production process, with Aquasta yielding an overall recovery of 94 percent from start to finish, including the conditioner, extruder and dryer process (Storebakken, et al 2004).
Another stability study was conducted during the feed storage process at ambient room temperature (24°C to 11°C with an average of 17°C) using six samples of feed from seven periods (Day 0 to Day 90 with 15 days between each analysis), with Aquasta yielding a 99 percent astaxanthin recovery after 60 days of storage and a 91 percent astaxanthin recovery after 90 days of storage.

AQUASTA IN THE FISH STUDIES

In order to determine the effectiveness of naturally sourced astaxanthin on various sizes and species of fish, Naturxan has conducted the Aquasta Customer Satisfaction Program on millions of fish throughout many growing seasons. This database benchmarks astaxanthin retention and color expression of Aquasta at commercial-scale fish farms and is used to help feed manufacturers and fish producers achieve a desired color level upon harvest.

Astaxanthin retention can vary by mean weight, food conversion rate, sanitary status, pigmentation strategy and species, with the Aquasta study demonstrating average astaxanthin retention of 8-11 percent in Atlantic salmon, 20-25 percent in Rainbow trout and 15-20 percent in Coho salmon (Aquasta Customer Satisfaction Program, 2001-2008).

Fig. 1 Astaxanthin retention on flesh: Atlantic salmon

Fig. 2 Astaxanthin retention on flesh: Rainbow trout
Acceptable color expression is determined by the demand found in the destination market for the aquaculture product and therefore is factored into the overall pigmentation strategy, with the Aquasta study indicating an average SalmoFan score of 26-28 in Atlantic salmon and 28-30 in large Rainbow trout and Coho salmon (Aquasta Customer Satisfaction Program, 2001-2008).

Naturxan, LLC, a joint venture between Archer Daniels Midland Company and Igene Biotechnology, Inc., is the world’s leading provider of naturally sourced astaxanthin from Phaffia yeast, serving customers large and small in aquaculture markets around the globe for more than a decade.

Naturxan recently completed an expansion of its production and distribution capabilities to provide worldwide availability of Aquasta, a naturally sourced astaxanthin made from Phaffia yeast for enriching and pigmenting salmon and trout consuming aquaculture feeds. Naturxan invested more than $3 million of capital and dedicated significant science and engineering resources into scaling production capacity and inventory volume to fulfill ongoing customer demand. With customers in more than a dozen countries, along with export and distribution centers in North America, South America, Europe, Australia and Asia, Naturxan continues to meet worldwide demand for naturally sourced astaxanthin for use in both specialty and commercial-scale feed and fishing operations.
All of these studies indicate that naturally sourced Aquasta astaxanthin is a reliable source for feed manufacturers and fish producers to fulfill the pigmentation strategies of organic aquaculture markets around the world and address the rising consumer demand for renewable, natural product sources.

For more information or to obtain literature references, please contact Stephen F. Hiu, Ph.D., Chief Technology Officer, Naturxan, LLC. Or visit the Naturxan website.
Salmon feed breakthrough

Ocean Harvest Technology, based in Galway on the Atlantic coast of Ireland, is about to start commercial production of a new salmon feed ingredient that could revolutionize the €6 Billion global salmon farming industry.

The industry has been beset by concerns over environmental impact, animal welfare and food safety concerns but all of those issues will be addressed by OceanFeed, a wholly sustainable, seaweed-based salmon feed ingredient that not only replaces all synthetic chemical additives and colorants currently used in salmon fish feed - but also has been shown significantly to improve the health environment in which the fish are reared.
NATURAL AND WHOLLY SUSTAINABLE

OceanFeed is a macro algae-based ingredient which is 100 per cent natural and wholly sustainable within the ocean environment. Recently completed European sea trials with aquafeed company, EWOS, in Scotland, have shown that the thousands of fish used in the trial have been healthier and displayed better weight gain, taste and appearance results when compared to fish fed on the current market leading feed.

Astaxanthin levels in fish fed on the OceanFeed diet were only 20 per cent of those in the control diet fed fish while OceanFeed contained higher levels of natural pigments, notably Lutein, and of Omega-3 PUFA’s.

The feed ingredients are designed to reduce stress, enhance the immune system and minimize autoimmune problems, at the same time, the fish eating OceanFeed have significantly improved flesh quality and flavor - the ‘taste of the sea’ compared to a control test group.

The feed reduces many of the environmental issues associated with current aquaculture practices. Many of these have related to the use of synthetic, petroleum-based additives that represent about 20 per cent of the cost and 15 per cent of the weight of farmed salmon fish feed. The market for additives used in the manufacture of salmon feed was worth more than US$615 million in 2007.

OceanFeed is the first commercial product to emerge from several years’ worth of research and development into the application of macro-algae and seaweed based products conducted by the team at Ocean Harvest Technology. The company was founded by Patrick Martin, an Irish born seafood expert with over 25 years experience in aquaculture around the world; and Dr Stefan Kraan, a Netherlands born world expert in seaweed, who formerly headed the Irish Seaweed Centre at the National University of Ireland, Galway. The company’s Technical Director is Colin Mair, a veteran in the field of aquatic feeds, pet food, snack foods and breakfast cereals who has worked across Europe, the United States and Japan.

“It was during research into the commercial application of seaweed derived products that the potential emerged for a sustainable ingredient in the salmon feed industry, said CEO Patrick Martin. “After many years of development, we moved from testing in small numbers to major ocean testing with some of the biggest players in the salmon market.”

“As an industry, salmon farming has taken significant criticism in terms of environmental impact. The long term importance of aquaculture in helping to feed the world has always meant that sustainable solutions would need
to be found and our belief is that OceanFeed will be a key ingredient in helping to make the industry more environmentally as well as financially sustainable.”

LEADING CENTERS

“We are creating a company in the West of Ireland that will have the capacity to supply the world’s leading centres of salmon farming in Scotland, Norway and Chile.”

“The complex blend of seaweeds that are in OceanFeed allows salmon to be raised in a wholly natural way,” said Stefan Kraan. “We have to look at our oceans in order to be able to feed the world in the future. OceanFeed fits right into that strategy and facilitates the continued development of a better, wholly sustainable food source.”

Commercial production of the feed will commence in the coming months at the company’s Irish facility. A number of the key seaweed components in the feed are sourced exclusively within Irish coastal waters, with others imported from around the world.

Test results also have confirmed that fish eating Ocean Feed have increased resistance to sea lice infestation. Sea lice are a major problem in salmon farming. Control of sea lice costs the industry more than US$100 million a year.

It is claimed that wild fish populations are affected because of sea lice infestation caused by salmon farms and infested fish are much more susceptible to disease. There is resistance to the use of chemical treatments to control sea lice and a natural approach such as the use of Ocean Feed™ in the feed is much more acceptable.

POSITIVE ENVIRONMENTAL IMPACT

The seaweed ingredients used in OceanFeed are subject to minimal processing at low temperatures, resulting in the retention of all bioactive molecules. It allows for greater support of the salmon, the consumer and the ocean environment. The careful cultivation of the seaweeds used to make the feed blend also has a positive effect on the environment. The biomass being grown represents a new carbon sink, or reservoir for carbon-containing chemical compounds, and the areas where the seaweed grows are safe nursery areas for marine life.

The potential impact on the industry is profound. The whole concept of using natural sea vegetables to feed farmed fish in a controlled, environmentally sympathetic cycle is attractive and acceptable. The sea is a largely untapped resource and the use of seaweed takes pressure off of land-based resources, helping to alleviate the problems caused by increasing demands on terrestrial resources caused by increased population and consumption.

For more information about OceanFeed, please contact Patrick Martin.

More technical details and the results of feeding trials with Marine Harvest and EWOS will be featured in the next issue of Aquafeed: Advances in Processing and Formulation.
Get more out of your aquafeed ingredients 4

MAXIMIZING PERFORMANCE BY OPTIMIZING GUT HEALTH

By Peter Coutteau, PhD. Alexander van Halteren, & Sam Ceulemans
NUTRIAD International, Kloosterstraat 1, 2460 Kasterlee, Belgium

The strong fluctuations of feed ingredient prices in combination with low market prices for aquaculture products challenge the profitability of many aquaculture operations around the globe. This has accelerated a search for alternative formulations and feed additives to improve the cost efficiency of feeding under various scenarios of ingredient cost and availability. In previous contributions in AQUAFEED: Advances in Processing & Formulation we discussed the use of digestibility enhancers to optimize nutrient digestibility and feed utilization for different fish species. The present article illustrates the potential to reduce cost of feeding in aquaculture through the improvement of gut health in fish and shrimp.

In the livestock industry, combined research efforts from producers, feed and additive suppliers, and academic institutes have resulted in a vast knowledge base and a wide range of additives to alleviate fluctuations in the cost of feed formulations for poultry and pigs. By contrast, aquaculture nutritionists have paid little attention so far to the optimal functioning of the digestive system of fish and shrimp. As prices of aquafeed ingredients are rising, nutritionists may find new options for cost reduction in the formulation by maximizing the efficiency of digestive and metabolic processes which are at the basis of converting nutrients into growth.

In agriculture, various types of feed additives are being applied to enhance the digestibility and/or utilization efficiency of nutrients, including exogenous enzymes and various types of digestibility enhancers allowing the extraction of more nutrients from ingredients, flavors and palatability enhancers to stimulate appetite, and a wide range of products (pre/probiotics, botanical extracts, yeast derived products, ...) to maintain a healthy gut.

The feeding biology, digestive physiology and nutritional requirements of warm-blooded land animals differ significantly from those of aquaculture organisms. Therefore, the direct application in aquaculture of nutritional and/or functional feed additives developed for livestock is often not trivial. The present article illustrates the potential to reducing cost of feeding in aquaculture by the application of novel feed additives, targeting mainly to improve the efficacy of nutrient utilization and gut health.
GROWTH PROMOTION BASED ON OPTIMIZED GUT HEALTH AND INTESTINAL MICROFLORA

The ban on the use of antibiotic growth promoters in poultry and pigs, and the subsequent search for alternatives, has revealed the importance of gut health and the development of a stable, favorable gut microflora, on feed efficiency, overall performance and productivity. Fish and shrimp are highly exposed to exchanges of microflora between the environment and the digestive system. This increases the risk for the proliferation of an unfavorable gut microflora or frequent destabilization of the microflora, which can affect the optimal functioning of the digestive system. Furthermore, the digestive system of fish and shrimp is the main entry port for bacterial and viral infections, which remain a major risk for the profitability of aquaculture production.

Sustainable approaches to modulate the gut microflora in farmed animals include the use of selected bacteria to inoculate the gut (probiotics), specific nutrients promoting the development of selected bacterial strains (prebiotics), and specific natural compounds (mostly derived from yeast and herbal extracts, so called “phytobiotics”) capable of modulating the microflora towards a favorable composition, favoring the development of beneficial bacteria and inhibiting potentially pathogenic micro-organisms. The latter strategies have the advantage of being easily applicable at the feedmill on large volumes of feed and avoiding major adaptations of the production protocols at the farm.

A synergistic blend of phytobiotics was selected for their bacteriostatic and bactericidal properties against pathogenic and potentially pathogenic bacteria in vitro using the disk diffusion method. This blend was capable of promoting growth significantly in feeding trials with healthy specimens of different species of fish and shrimp growing under controlled lab conditions (Figure 1). Under controlled lab conditions, healthy shrimp showed a remarkable 20% increase of weekly weight gain and 4% improvement on food conversion (Table 1).
Table 1: Growth and feed utilization of *Litopenaeus vannamei* fed 56 days a control diet or the same control diet supplemented with a synergistic blend of phytobiotics (SANACORE® GM) (clear water tanks of 1 m³, 20 shrimp per tank, average from triplicate tanks ± stdev; Ceulemans & Coutteau, unpublished data).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL</th>
<th>SANACORE® GM</th>
<th>% difference</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival (%)</td>
<td>87 ± 3</td>
<td>88 ± 6</td>
<td>+2%</td>
<td>0.678</td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>0.99 ± 0.01</td>
<td>0.98 ± 0.01</td>
<td>-1%</td>
<td>0.591</td>
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<tr>
<td>Final weight (g)</td>
<td>8.73 ± 0.34</td>
<td>10.29 ± 0.38</td>
<td>+18%</td>
<td>0.006</td>
</tr>
<tr>
<td>Growth (g/week)</td>
<td>0.77 ± 0.04</td>
<td>0.93 ± 0.04</td>
<td>+20%</td>
<td>0.006</td>
</tr>
<tr>
<td>Feed Intake (%/Average Body Weight/day)*</td>
<td>5.0 ± 0.2</td>
<td>5.0 ± 0.1</td>
<td>-</td>
<td>0.846</td>
</tr>
<tr>
<td>FCR</td>
<td>2.21 ± 0.05</td>
<td>2.12 ± 0.04</td>
<td>-4%</td>
<td>0.074</td>
</tr>
</tbody>
</table>

* feed intake/((initial weight+final weight)/200)/trial days

Figure 1:

Percentage improvement of growth and feed conversion ratio (FCR) due to supplementing a phytobiotic growth promoter based on microflora modulation (SANACORE® GM) to a practical feed of different aquaculture species. Data show relative effect on growth (for fish: SGR, %/day; for shrimp g/week) and feed conversion ratio (FCR) relative to the performance of the non-supplemented control group in a feeding trial with healthy animals. Feeding trials were run in triplicate tanks for Gilthead seabream *Sparus aurata* (trial duration 56 days; starting from 70g); Nile tilapia *Oreochromus niloticus* (70 days; starting from 17g); and white shrimp *Litopenaeus vannamei* (56 days starting from 1g) (Ceulemans et al., 2010).
EFFECT OF OPTIMIZING GUT HEALTH AND INTESTINAL MICROFLORA ON PRODUCTIVITY AND ECONOMICS OF SEMI-INTENSIVE SHRIMP FARMING

The efficacy of phytobiotics was tested under the field conditions for shrimp production in Panama during the dry season (September 2009 - February 2010) by Vaca et al. (2010). The dry season in Panama is characterized by unstable climatological conditions, resulting in strong temperatures fluctuations which in turn affect shrimp growth and increase the impact of outbreaks of white spot virus (WSSV). During the trial, two treatments were compared which only differed with regard to the supplementation or not of a phytobiotic growth promoter (Sanacore GM, Nutriad, Belgium) to the standard feed used at the farm.

The supplementation of the phytobiotic feed additive resulted in improved values for all production parameters analysed in this study (Table 2; Fig. 2). Survival and processed crop yield (kg/ha) presented highly significant improvements (P<0.03), amounting to a relative increase with 24% and 35% compared to the control group, respectively. Although the other parameters did not show significant differences, important improvements were observed for the treatment receiving the phytobiotic, including 5.8% larger average shrimp size at harvest and 12% better feed conversion compared to the control group. The addition of the phytobiotic reduced drastically the variability of production results among ponds fed the same feed (average coefficient of variation between ponds for the 6 production parameters : control 18% versus SANACORE group 10%; Table 2).

Top right: Feeding manually from a boat in the CAMACO farm, Panama (by courtesy of Jorge Cuéllar-Anjel)
Centre right: Weekly sampling using cast nets at the CAMACO farm, Panama (by courtesy of Jorge Cuéllar-Anjel)
Bottom right and left: Harvesting shrimp at the CAMACO farm, Panama (by courtesy of Jorge Cuéllar-Anjel)
The supplementation of the phytobiotic feed additive resulted in improved values for all production parameters analysed in this study (Table 2; Fig. 2). Survival and processed crop yield (kg/ha) presented highly significant improvements (P<0.03), amounting to a relative increase with 24% and 35% compared to the control group, respectively. Although the other parameters did not show significant differences, important improvements were observed for the treatment receiving the phytobiotic, including 5.8% larger average shrimp size at harvest and 12% better feed conversion compared to the control group. The addition of the phytobiotic reduced drastically the variability of production results among ponds fed the same feed (average coefficient of variation between ponds for the 6 production parameters: control 18% versus SANACORE group 10%; Table 2).

Table 2: Production results after processing for control ponds and treatment ponds receiving phytobiotic supplement (Sanacore® GM) after 141 days of culture (average and standard deviation of 8 replicate ponds of 3ha per treatment; Vaca et al., 2010).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Survival (%)</th>
<th>Shrimp size (g)</th>
<th>Crop Yield (kg/ha)</th>
<th>Feed (kg/pond 3ha)</th>
<th>FCR</th>
<th>Weekly Growth (g/wk)</th>
<th>Average coefficient of variation for parameters listed (CV%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanacore® GM</td>
<td>55.5 ± 7.1 a</td>
<td>16.6 ± 1.5 a</td>
<td>735 ± 78 a</td>
<td>4,170 ± 338 a</td>
<td>1.91 ± 0.23 a</td>
<td>0.825 ± 0.075 a</td>
<td>10%</td>
</tr>
<tr>
<td>Control</td>
<td>44.6 ± 10.6 b</td>
<td>15.7 ± 2.9 a</td>
<td>543 ± 90 b</td>
<td>3,464 ± 396 b</td>
<td>2.17 ± 0.39 a</td>
<td>0.776 ± 0.137 a</td>
<td>18%</td>
</tr>
<tr>
<td>% change Sanacore vs Control</td>
<td>+24.4%</td>
<td>+5.8%</td>
<td>+35.2%</td>
<td>+20.4%</td>
<td>-12.1%</td>
<td>+6.3%</td>
<td>-41%</td>
</tr>
<tr>
<td>P Value</td>
<td>0.0304</td>
<td>0.4395</td>
<td>0.0004</td>
<td>0.0018</td>
<td>0.7130</td>
<td>0.3876</td>
<td>---</td>
</tr>
</tbody>
</table>
The drastic effects of the phytobiotic product on survival may be related to the fact that this study was performed during the worst farming cycle of the year in Panama, when shrimp ponds are exposed to severe transitional changes in weather at the end of the wet season and the beginning of the dry season. Natural White Spot Disease outbreaks were observed during shrimp farming in both treatments under similar frequency and severity; WSSV virus was confirmed by immuno-chromatography and nested-PCR tests. The presence of a synergistic blend of phytobiotics with antimicrobial activity, possibly protected the shrimp from co-infections with opportunistic bacteria, often the major cause of mortality in WSSV-infected shrimp. Higher crop yield per hectare due to better survival often results in slower growth due to reduced availability of natural food. Despite significantly higher survival and crop yield, a positive effect was observed of phytobiotics on growth rate and food conversion. This confirmed that the continuous dosing of natural anti-microbial activity in the feed results in beneficial physiological effects from stabilizing the microflora present in the digestive system.
In conclusion: current aquafeed formulations are mainly focused on nutritional specifications and ingredient choice, whereas the optimal utilization of the nutrients by the fish and the health status of the digestive tract are two areas which are rarely taken into account. This is in strong contrast with the vast progress made in the agrifeed sector, where nutrient digestibility and gut health are regarded as two focus areas for technological feed development. The current paper illustrated with lab and field studies the potential benefits for aquaculture in terms of productivity and economics of specific feed additives developed to enhance the functioning of the digestive tract, either by improving the nutrient utilization or by stimulating the development of a healthy gut microflora.

For more information and references, please contact Dr. Peter Coutteau.

Pull up a chair at the all new Aquafeed Discussion Group

Find us on the Aquaculture Hub at
 http://www.aquaculturehub.org/group/aquafeed
PescaMaris is reviving the lost industry of intensive shrimp farming in Ecuador. Several years ago, white spot disease decimated the entire industry, but now PescaMaris S.A. has started its second year of production and is greatly exceeding performance from years past. Located just outside of Montecristi in the Manabi province of Ecuador, the seven hectare intensive site can equal the production of 150 hectares of traditional open water farms.

“In intensive shrimp farming, the most critical requirement is to maintain the quality of the water which in turn maintains the health of the population” said Ernesto Cardenas, the General Manager of the operation. We have found some unique combinations which allow us to improve our FCR, decrease the cost/kg of our feed and ultimately to increase our total output per hectare.”

One key aspect which PescaMaris credits for the improvement in their operation is the strategic use of Fish Peptide/Nucleotide Isolates in several steps during its production. Ernesto’s creativity goes back many years to when he blended/created shrimp feed formulas while working at AgriPac Balanfarina, one of the largest feed companies in Ecuador. Now with new sources of Peptides+Nucleotides at his disposal, and his own farm to work with, he has found multiple ways to catalyze the growth of the shrimp.
MANAGING WATER QUALITY: GETTING THE NATURAL PROBIOTIC BACTERIA TO THEIR HIGHEST LEVELS.

Inoculating the ponds with good bacteria is a standard practice in high quality shrimp operations - and it is even more critical for intensive farms. PescaMaris has enhanced this process by adding Bluewave Perfect-Digest FPi (Fish Peptides Isolates) during the bacterial “fermentation” process at the farm. The peptide/nucleotide base is produced at the Marine Protein S.A. factory, Manta Ecuador.

**Traditional Formula:** During the first 10 days of fermentation, sugar molasses is typically used a ratio of 20L per 1L bacteria is mixed with 1,000L of water to create a full batch to be fed into the ponds. With this standard recipe, the molasses is the only food source for the bacteria in the holding tank.

**New Formula:** By altering the feed for the bacteria to include 10L of FPi Peptide and 10L of molasses, PescaMaris has began utilizing the same technique that many world class pharmaceutical companies do every day…..exponentially accelerating the growth of the bacteria with peptides (higher population in fewer days). The increase in population inside the fermentation tank results in more bacteria reaching the water with each application - more bacteria produces more work on the biomass in the water - and ultimately cleaner ponds with healthier shrimp.

BETTER, CHEAPER FEEDING: DIY - DO IT YOURSELF (OR AT LEAST 20% OF IT)

Everyone knows that feed is the highest cost component for commercial production and finding a way to reduce feed cost by 10% using peptides is another success at PescaMaris. This process begins by replacing 20% of the expensive manufactured feed ($28/bag) with a blend of traditional “dry grain silage” ($8/bag). But in order to bring the grain-silage to shrimp feed quality, it must be top-dressed with the PerfectDigest FPC ($4/application). This results in a $12 feed bag vs $28 from the mfg. The FPC for this application is a combination of fish peptides-nucleotides and fish fats/oils. The mix is allowed to set for about one hour prior to feeding - this allows the FPC to saturate into the grain-silage. The solubility of the Peptide allows for partial release when the feed hits the water serving as an attractant for the shrimp, but it also ensures the shrimp consume all of the low cost grain/silage material”, firstly because they find it, and secondly, because the grain retains a fish taste as a result of the long soak. Top-dressing grain-silage
with fish peptide has direct implications when considering the use of other “waste grain products” such as Distiller Dried Grains (DDGs) in Aquaculture Feeds. With massive amounts of low cost DDGs available on the market, and a newly designed program to treat with fish peptides - shrimp farmers around the world will be able to benefit from lower feed costs - and improve feed conversion by using these techniques. Gently placing the feed tray/nets and lowering into the pond, rather than just throwing pellets is another example of technique which helps more of the feed to reach the shrimp and not be lost in the water.

KNOW IT FOR SURE: GUARANTEED INCLUSIONS AND PROTEINS WHICH ARE NOT DENATURED.

Making fish peptide additions on the farm, rather than hoping they have been included at the feed mill has some major advantages. For one, the farmer can be assured of exactly how much Peptide is being included in the feed program. Feed mill recipes change - and with the recent high fishmeal prices and sometimes short supply, there has been pressure to reduce its inclusion resulting in lower performing feeds.

Top dressing with the liquid FPi & FPs assures that the peptide has not been denatured during the steam extrusion process at the feed mill. This means the Peptides have maximum bio-activity when they reach the water. In Nature, shrimp eat raw marine components as part of their natural diets - adding the FPi or FPs provides bioactive peptides & nucleotides in a “non-cooked” condition - similar to the way they occur in nature. This format allows for a “lower net inclusion rate” of fish based ingredients, without affecting final performance. Some farmer are concerned that when the peptide leaches from the feed it is lost in the pond - however, what they fail to realize is that the bacteria population in the water quickly consume the peptide and form a floc which in turn the shrimp will feed upon.

SUSTAINABLE PRODUCTION: SMALL FOOT PRINT, RECYCLED WATER, LOWER FISHMEAL FEED CONTENT AND BY-PRODUCT FEED INGREDIENTS ARE THE CORNERSTONES OF THE PROGRAM.

Footprint: As was previously stated, the farm currently operates on only seven hectares, and is producing about 13.5 tons of shrimp per hectare - this compares to 650kg/hectare with open water farms.

Recycle: The ground water has high salinity (which is great for the shrimp) however, there is limited quantities - so PescaMaris incorporates water recycle through a large ‘post pond holding area’. When the ponds are drained, the water has several weeks to recover in the holding area, where it can later be re-used in subsequent ponds. During production cycles they operate at Zero Water Exchange - instead they
maintain >5ppm oxygen level, relying on the bacteria to keep the water clean along with continuous paddle wheel aeration.

Utilization of the liquid fish peptide on site in conjunction with the grain-silage feed, lowers the total fishmeal content of the diet by about 20%. Applying some “think globally, act locally” mathematics, this 20% reduction has the ability to make a major impact on the 5MM+ tons of fishmeal used in AquaCulture each year. And the products which PescaMaris has chosen all come from by-product sources, thus further reducing the impact on wild-catch fishmeal.

In summary: farming is a business, and economical success is the final measure of the program - this cycle has shown a great improvement over the last cycle and. FCR has improved from 1.7 in year 2009 down to 1.3 in the current program (yes this number is correct) and currently the ponds receiving the peptide program are two weeks ahead of the neighboring control pond.

Below is a quick summary of other performance from this cycle.

- Survival rate: 85%
- FCR: 1.25
- Harvest Shrimp size: 10g
- Yield per hectare: 18,000lbs
- Temperature: 23C
- Days of Cycle: 84
- Feed Cost/kg of shrimp: 0.9 cents

Historically, intensive farming is up to 30% higher in unit cost of production versus extensive, but today PescaMaris nearing the same unit cost.

The entire peptide feed program has been developed in conjunction with technical support from a local Ecuador distributor Representaciones Acuicolas managed by Jorge Cepeda. The company has spent the last six months testing and analyzing shrimp feed programs with numerous local producers as well as analytical work utilizing peptides for fermentation bacteria.

For more information, please contact Mark Rottmann or visit www.PerfectDigest.com. The results of the independent research can be found here.
MARINE PHOSPHOLIPIDS IN SHRIMP NUTRITION

A new class of highly valuable nutrients

Michael Schneider Ph.D., TripleNine Pharma, Esbjerg, Denmark

Shrimp culture has expanded and intensified rapidly around the world during the last two decades. The development of nutritionally complete shrimp diets is necessary for a further intensification of this industry in the years to come. The knowledge of the shrimps’ nutritional requirement is essential to achieve better survival, growth, stress resistance and a reduction of the occurrence of deformities. A new class of highly valuable lipids – marine phospholipids - have now been made available for large scale applications at affordable cost.

FATTY ACID REQUIREMENT IN SHRIMP

Crustaceans have a limited ability for de novo synthesis of fatty acids both of the omega-6 and omega-3 family. Consequently they require a dietary source of essential fatty acids. In early studies of Kanazawa [1 - 4] it was demonstrated that the long chain polyunsaturated omega-3 fatty acids (LC-PUFA) are the most essential ones followed by linolenic and linoleic acid. It was suggested that a minimum of 1 % of LC-PUFAs (EPA and DHA) should be included in a diet for postlarval penaeids. The capacity of synthesizing EPA and DHA from dietary linolenic acid is particular low in a number of shrimp species.

ROLE OF DIETARY PHOSPHOLIPIDS

Phospholipids are phosphorus containing polar lipids. Chemically they are diglyceride derivatives of a phosphoric acid ester with a hydroxyl group bearing molecules such as choline, ethanolamine, serine or inositol. Their fatty acid residues vary in chain length and degree of unsaturation.

Phospholipids (PL) are the major constituents of all cell membranes and are vital to the normal function of every cell and organ. They maintain cell structure and function and have regulatory activities within the membranes and outside the cell. For instance they serve as second messengers in cell signalling, an essential process in regulating cell growth, proliferation, differentiation, metabolism, nutrient uptake, ion transport and even programmed cell death.
Phospholipids act as emulsifiers and facilitate the digestion and absorption of fatty acids, cholesterol and other lipophilic nutrients. They also have a role in the transport of lipids, not only in the transport of absorbed lipids from the gut into hemolymph, but also the transport of lipids between tissues and organs [5], as phospholipids are constituents of the circulating lipoproteins. Phosphatidylcholine (PC) is particularly important because it is an essential component of these lipoproteins [6]. Dietary phospholipids may serve as a source of choline, inositol, LC-PUFAs or even energy. For early stages of crustaceans it has been suggested that phospholipids presented in the diet serve as a direct source of these nutrients [7].

However, the effect of PLs on growth and survival of crustaceans seems to vary with the fatty acid composition and the kind of compound esterified with the phosphoric acid. Apparently, effective PLs need to possess choline and inositol groups besides highly unsaturated fatty acids of the omega-3 class [8].

It has been suggested that crustaceans prefer PLs to triglycerides as a source of fatty acids. It has also been demonstrated in animal models that the bioavailability of LC-PUFAs is much better as compared to triglycerides [9]. To date lots of studies have demonstrated the beneficial effect of supplementing PLs to the diet of a large number of shrimp species [10 - 14]. Growth and survival rate increased with increasing levels of PC and omega-3 LC-PUFAs. The fatty acid level and composition of shrimp tissue was very much influenced by dietary levels of PC and fatty acids.

**SOURCES OF PHOSPHOLIPIDS**

All products of plant and animal origin contain PLs, but not all contain high levels of specific phospholipids required for shrimp nutrition. Esp. LC-PUFAs like EPA and DHA are not present in all vegetable phospholipids. So have soya phospholipids for example, the most widely used phospholipid source for animal
nutrition, a relatively low PC content, a low omega-3 fatty acid level and even absolutely no omega-3 LC-PUFAs.

It is more than logic that for feeding aquatic species the phospholipids from the same environment exhibit the most promising nutritional properties.

Marine phospholipids are rich in phosphatidylcholine and - inositol and have an extremely high content of highly bio-available omega-3 long chain polyunsaturated fatty acids (EPA and DHA).

Phospholipids are essential nutrients for shrimp feed preparations. In particular phospholipids from marine raw materials are extremely high in the most valuable class of phospholipids (PC and PI) as well as high in omega-3 long chain polyunsaturated fatty acids, both EPA and DHA.

With the development of innovative processes to obtain marine phospholipids in excellent quality and composition it is now possible to consider the inclusion of these highly valuable ingredients even in compounds for animal, especially shrimp feed compositions.

LITERATURE REFERENCES

Coutteau, P. et al., Aquaculture, 147, 261 (1996)
Coutteau, P. et al., Aquaculture, 155, 149 (1997)

For more information about marine phospholipids, please contact Hans Otto Sørensen or visit www.999.dk
Phytogenics are plant derived products. The active ingredients (e.g. phenolic and flavonoids) can exert multiple effects in animals, including improvement of FCR, digestibility, growth rate, reduction of nitrogen excretion and improvement of the gut flora and health status (Kroismayr, 2007; Steiner 2006). The underlying mode of action of phytogenic compounds range from a direct reduction of the gut pathogenic bacteria to a stimulation of growth and acid production by beneficial species such as Lactobacillus, to the enhancement of specific elements of both humeral and cell-mediated arms of the immune-system (Cardozo et al., 2008).

In farmed aquatic species, the beneficial effects of phytogenics have been reported in several studies which showed that the application of these feed additives can also be important for the aquaculture industry (Encarnação, 2009).

Despite consistent improvements with conventional phytogenic products based on essential oils, these sensitive substances have a tendency to lose their efficacy and efficiency due to their susceptibility to high temperatures, remarkable odor and volatile properties. Therefore, the application of essential oils in aquaculture feeds can benefit from the delivery of the product in an encapsulated form.

Microencapsulation is a technology that allows the protection of certain substances into a sealed
capsule. In the course of ongoing research and development of innovative products, Biomin was able to trap its phytogenic feed additive into a capsule by a modern matrix-encapsulation process. This resulted in a new product with all the benefits shown by previous encapsulation techniques, while avoiding ingredient losses during feed processing (pelleting or extrusion) and storage. The carrier used in this new product is a blend of carbohydrates which are processed in an extruder to form the matrix capsule. The process reaches high temperatures above 100°C for a defined period of time when the essential oils are sprayed into the matrix and sequenced by the die to cutting and forming the matrix-encapsulated P.E.P. product (Figure 1).

This approach of encapsulating essential oils led to the new generation of phytogenic feed additives, named Biomin P.E.P. MGE (Figure 2). In contrast to conventional wax or fat coated products, in Biomin P.E.P. MGE the active ingredients are evenly distributed in a matrix and continuously released in the digestive tract which represents an additional advantage.

A series of trials recently performed with the new encapsulated phytogenic product confirm that for fish
as well as for shrimp, consistent improvements in growth rate and feed conversion ratio (FCR) can be achieved (Figure 3). At the Aquaculture Centre for Applied Nutrition in Thailand, a reduction of 6.4% in FCR was observed in Tra catfish (*Pangasius hypothalamus*) fed diets supplemented with Biomin P.E.P. MGE. In another trial performed at Kasetsart University, Thailand, white leg shrimp (*Litopenaeus vannamei*) fed with Biomin P.E.P. MGE had FCR (Figure 3) and growth improved by 4.7 and 20%, respectively. Size distribution of shrimp was also improved as it showed that 57.5% of shrimp fed the control diet were in a small size class (<5.5 g/ind.), whereas 51.3% of shrimp fed the diet supplemented with Biomin P.E.P. MGE were in a larger size class (>6.6 g/ind.). In addition shrimp survival was also improved by 20% by the supplementation of the phytogenic additive to the diet.

The innovative encapsulation process represents an additional benefit which enables the phytogenic additive to have a longer shelf life by protecting it from environmental impacts, partly masking the strong flavour of essential oils whilst maintaining its key features of enhancement of palatability, stability, improved digestion and, consequently, better performance.

For more information please contact Gonçalo Santos. References available on request.
In 2050, the world’s population - probably nine billion inhabitants - will obtain a significant part of their daily protein needs from cultured fish. Even today, aquaculture provides almost half of the fish consumed worldwide, with a global growth rate of 8% per year. The way this cultured fish is produced has become a crucial issue for the consumer, the industry and the environment.

Major fish pellet suppliers rely on extrusion technology for these answers. A pioneer in the fish feed industry since the ’70s, Clextral has continuously provided an evolving technology with flexible and accurate solutions. Twin screw extruders can process a very large range of raw materials into high quality fish feed, from micro up to macro feed while ensuring the requested sinking properties and nutritional needs.

Fish farmers are facing several new challenges: preserving fish health, developing consumer confidence and maintaining a sustainable development.

The decreasing availability of fishmeal and fish oil is leading fish feed producers to use more vegetable proteins in place of fish meal and oil. Clextral’s twin-screw technology, with accurate control of process
parameters and mixing ability associated with a reliable and robust gear box, makes it possible to process any kind of material and to switch easily and rapidly from one recipe to another. One can observe as well, that due to the higher levels of vegetable proteins used in the recipes, the SME values are slightly increasing while maintaining consistently premium quality.

**PELLETS SIZE : MICRO AND MACRO FEED**

Water pollution from uneaten feed can be reduced by increasing the probability that the fish will ingest the pellets. The sinking or floating properties must be controllable and perfectly suited to each species’ behavior. The feed composition, denaturation of anti-nutritional components and starch gelatinization must be mastered for the fish to accept the pellet at its greatest potential and reduce its rejection. Accurate temperature regulation and control of all the parameters such as shear rate, residence time, drying efficiency and coating levels are necessary to produce micro fish feed with constant sizes and hardness for juveniles and macro pellets for big fishes, like tuna, for example. Last but not least, a reliable and precise cutting device must allow proper calibration of the granulates and avoid generation of fines.

Clextral has developed a system for processing feed as small as 0.5 mm, with sinking or floating properties which includes: special grinding, extrusion processing with advanced twin screw machines generally equipped with a venting system, and a unique drying process using the Rotante system; this First In-First Out (FIFO) design without cross contamination achieves excellent heat exchange and homogeneity with reduced energy consump-
tion; it offers gentle heat treatment with accurate residence time control, perfectly adapted to the process of sensitive materials.

The manufacture of very large pellets, such as 30 mm, requires specific expertise in process control (shear, temperature, die design) and post processing such as cutting the pellets and further drying: here again, the Rotante system allows a very gentle heat treatment which preserves the integrity and shape of these products. Finally, vacuum coating achieves high flexibility when enrobing these large pellets.

ENVIRONMENT

Expertise in limiting the environmental impact of its technologies has long been a reality at Clextral, as confirmed by its ISO 14001 certification and low carbon footprint guidelines for the equipment design.

Clextral is totally committed to helping the fish feed industry face its challenges and continues to offer experience and advanced technology to scientists and suppliers - together we can build long lasting solutions for world nutrition.

For more information about Clextral’s aquafeed processing technology, please contact Alain Brisset or visit www.clextral.com
The past decade has seen major development in the production of extruded aquafeeds. An important part of this development has been in the addition of different liquid additives such as oil, vitamins and medications.

Producing high quality aquafeed involves a careful selection of ingredients and the right processing technology: the deep core penetration of liquids into the pellets made possible by the Forberg RVC (rotating vacuum coater) has had an important impact on feed quality.

Forberg International AS has been in the front line with vacuum coating ever since the process was introduced to the industry for making pelleted fish feed in the early ‘90s. This technology has made it possible to increase the level of energy in the feed to new and higher levels. It is very important to keep the pellets dry on the surface even after adding high amounts of oil and different liquids, and the process of vacuum-assisted addition of liquid in the pellets plays an important role.

Forberg RVC (rotating vacuum coater)

The Forberg RVC is a machine that has been specially developed for using vacuum to improve the intrusion of liquids into the porous extruded pellets.

Important features are:

- Sanitary design;
- 100% batch integrity;
- Eliminating the risk for leakage due to loading and unloading of the machine through the same valve;
- Ensuring very low wear and breaking of the pellets during the process due to the smooth process chamber with accurately adapted rotors;
- Total control of the vacuum cycle with regards to the rate of equalizing back to atmospheric pressure gives an optimum capacity of inclusion;
- Thorough cleaning in a fast and efficient way by including Cleaning In Place (CIP) system;
- Easy to change between formulas without the risk of cross contamination.
CYCLE AND PRINCIPLE OF OPERATION

When the pellets have been loaded through the inlet valve, the valve is closed and the preset level of vacuum is obtained.

The next step is to add liquid additives through the single-component nozzles on the machine while the rotors are running. The Forberg RVC’s well known ability to fluidize the product and high internal transport capacity are the important reasons why it is possible to achieve such a high level of distribution of the different liquids. The principle allows perfect distribution directly on each pellet even for very small quantities of liquid additive.

After the process of distributing the liquids onto the surface of the pellets, the carefully monitored process of equalizing the pressure inside the process chamber, back to atmospheric, presses the liquid inside the pores of the pellets, leaving the surface dry.

One of the most crucial parts of the vacuum coating process is the vacuum release. The Forberg RVC achieves optimum core coating results due, among other things, to specially designed computer controlled pressure release.

For more information please contact Hilde Nordahl or visit the Forberg International AS website.
The ability quickly and thoroughly to clean production processes is becoming increasingly crucial, as more and more producers choose to invest in a single process line for the production of several products. The quick and thorough cleaning achieved with the Hygienic Compact Containment system from Dinnissen Process Technology, Sevenum, the Netherlands, is based on its compact design and the fact that all the process equipment is quickly and easily accessible for cleaning purposes. This is also why Dinnissen fits its mixing and grinding installations with oversized inspection hatches and easily removable mixing shafts. As a result, all the interior parts of the machines are optimally accessible.
Dinnissen has succeeded in producing such a compact design by using accurate flow meters, dosage components and extremely accurate weighing systems. As a result, the systems can quickly and accurately dose various ingredients and process a large number of batches per hour. This makes it possible to achieve a high mixing capacity in spite of the compact design of the process equipment. This is possible even at ratios of coarse dosage/fine dosage of 1:500. In practice, Dinnissen’s systems allow coarse dosage rates of 20 tons per hour and fine dosage rates of 40 kg per hour (11g per second). The compact design of the processing equipment is very important in enabling production processes to be cleaned quickly and thoroughly.

CLEANING OF MIXING AND TRANSPORT SYSTEMS USING COMPRESSED AIR

The fully automated Dry Cleaning in Place concept, based on compressed air, was designed specially for companies that need to clean their mixing and transport systems quickly, efficiently and hygienically. The Dry Cleaning in Place technology cleans mixing systems completely automatically, using powerful blasts of compressed air and an interval switch. To achieve this, Dinnissen’s system employs tanks of compressed air and special nozzles installed at crucial locations in the mixing system. The equipment is blown clean on a step-by-step basis with the help of an interval switch, which ensures that the cleaning operation proceeds as programmed.

The blow-cleaning process starts from the weighing bunker and proceeds, from front to back (or from top to bottom), to clean every component of the mixer and storage bunker with the help of blasts of compressed air. After each compartment has been cleaned, it is automatically sealed off by special valves to prevent any raw material particles from moving backwards to previous parts of the chain. An efficient suction system removes all particles and dirt which have been blown away and transports them to an hermetically sealed section.

This new technology blows weighing bins, mixers and storage bins clean and empty at efficiencies of 99.9%. As the entire cleaning process is done with everything as dry as possible, caking, clumping and the
growth of bacteria and moulds are also effectively prevented. After their removal, expensive raw materials remain undamaged and can be reused without any problems. In addition, the system offers significant benefits in terms of labour saving and reduced downtime when switching from one product to the next. For companies which need the very highest level of hygiene, Dinnissen can fit the Dry Cleaning in Place system with extra options from its product range such as electrolytically polished surfaces.

HERMETICALLY SEALING OFF PROCESS APPLICATIONS

The entry of fine particles and microorganisms is a threat to the hygienic production of foodstuffs, particularly for companies operating in the food sector. In addition, the emission of toxic and sensitizing substances can pose a threat to worker safety, particularly in the chemical and pharmaceutical sectors. Dinnissen’s new Hygienic Compact Containment concept succeeds in hermetically sealing off production processes and preventing particles from coming in or out.

The concept is based on a combination of three functions. First, pressurization wherever ingredients are introduced into the system. The resulting pressure exerted from outside the system prevents any hazardous substances from escaping from connections and seams or joints. In addition, Dinnissen uses inflatable seals and air-seals with air pressure throughout the system. The end result is an hermetically sealed system, whereby dirt and microorganisms are not able to enter and hazardous substances are not able to escape. The use of pressurization and inflatable seals makes it possible to limit particle transmission to less than 0.1 mg per m³ of air. The Hygienic Compact Containment system is even effective against extremely fine particles (down to 10 nm). In situations that call for the very strictest standards of hygiene and safety, the system can be fitted with a controlled airflow facility. In such cases, a conditioned flow of clean or even sterile air is created, which flows in a safe direction, while potentially contaminated air is removed and transported elsewhere.

For more information about Hygienic Compact Containment, please contact Ingrid van der Sterren or visit www.dinnissen.nl

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AQUAFEED from Aquafeed.com
Mycotoxins are secondary metabolites of fungi that are unevenly distributed throughout the feed in hotspots and which can also be toxic in very low concentrations. Fusion, the latest developed product from Meriden Animal Health is the next generation of toxin binder that defines new limits to prevent the threat of in-feed mycotoxins in aquaculture feeds.

The experimental application of Aflatoxin B1 produced by Aspergillus, which grows on plant based feed ingredients, is negatively correlated with weight gain and survival in Penaeus monodon shrimp. In Channel Catfish histopathological changes in liver were noticed in Ictalurus punctatus when fed varying concentrations of the Fusarium mycotoxin fumonisin B1. In a commercial context the presence of mycotoxins are mainly manifested by stunted growth, reduced FCRs and reduced productivity with degeneration and atrophy of the liver in fish and hepatopancreas in shrimp.

The hypothalamic-pituitary-interrenal axis in fish, which can be stimulated by both environmental and stress events, affects the production of lymphocytes and antibody response as well as the reproductive capacity.

Gut Associated Lymphoid Tissue (GALT) is the interface between the diet, host physiology and gut microflora. GALT activity can be modified through the diet by three principles - competitive bacterial exclusion, bacterial antagonism and immune modulation which in turn affect the health and productive status of fish and aquaculture populations respectively. The development of Fusion from Meriden Animal Health Limited has been exclusively designed to optimize these complex biological associations. The combination of adsorption and biotransformation technologies used in Fusion has given rise to a product which has the ability to deactivate the major groups of mycotoxins found in aquaculture including Aflotoxins, Fumonisins, Trichothecenes, Ochratoxins, Vomitoins and Zearalenon. Fusion is a forward-thinking and innovative product which has raised the threshold standard to equivalent mycotoxin binders on the marketplace.
Effects of dietary levels of potassium diformate on growth, feed utilization and resistance to *Streptococcus iniae* of Nile tilapia, *Oreochromis niloticus*

Effect of potassium diformate (KDF) on growth performance of male Nile tilapia (*Oreochromis niloticus*)

Effects of diformates on growth and feed utilization of all male Nile tilapia (*Oreochromis niloticus*) reared in tank culture

Addcon also announces the successful test of its acidifier range, based on the diformate technology, in yet another fish species. A commercial scaled trial in milkfish marine cage culture was recently completed. First results showed significant effects of AQUAFORM on growth (13% surplus in weight gain) and feeding efficiency (FCR improved by over 10%) at inclusion rates of 0.3%.

**ADVANCED FORMULATION SOFTWARE IN BETA TESTING**

Format International’s new software product was on show for the first time in May. Based on cutting-edge Microsoft technologies and using Entity Framework database management, this new least-cost optimisation product offers unrivalled new possibilities in the user-experience, in business intelligence and in IT deployment.
It was presented in Manchester, UK, at Format’s International Agents’ Meeting. Delegates representing some 40 countries gathered for the three day conference to discuss recent developments in formulation techniques and computing technologies.

Ian Mealey, Format’s Head of Operations said “Only very recent developments in computing technologies have enabled this new software to take the form that we had long perceived and carefully planned. It offers a genuinely new way of delivering formulation software, which is not possible with software designed only a few years ago. This will provide users with an exceptionally easy interaction, business leaders with up-to-the-minute information and analysis and IT managers the opportunity to deploy a truly modern, secure tiered-server system in their preferred infrastructure.”

Format will be establishing a release date once beta testing is completed, and it is expected to be in 2010.
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