Corn Protein Concentrate: A cost-effective replacement for fish meal in shrimp diets

Poultry oil as a source of lipids in trout diets

Adifo celebrates its 40th anniversary - Double interview

New MS3000 Medium Shear Extruder for Fish Feed

An overview of the feeding management of farmed tilapia throughout the culture cycle

AMINODatAqua: an essential feed ingredient database for aquafeed producers

Photo: Poultry oil is a high quality lipid source for fish.
Inside this issue:

- Corn Protein Concentrate: A cost-effective replacement for fish meal in shrimp diets 3
- AMINODat®Aqua: an essential feed ingredient database for aquafeed producers 10
- *Poultry oil as a source of lipids in trout diets 18
- An overview of the feeding management of farmed tilapia throughout the culture cycle 20
- Adifo celebrates its 40th anniversary - Double interview: Two generations of specialists in the feed and aquafeed industry 27
- New MS3000 Medium Shear Extruder for Fish 32
- Reading Room 36
- Calendar of Events 42

* Cover Story

Advertisers

28  Adifo
31  Aquafeed Horizons Asia 2014
2  Buhler
9  Empyreal 75
41  FIAAP Conference Asia
35  FIAAP/Victam 2014
19  Geelen Counterflow
37  Hatchery Feed Guide 2014
30  Idah
34  Insta-Pro
43  ISFNF 2014
26  Muyang
24  Norel
13  Nutraferma
17  Skretting
18  Sonac
19  Uniqair
14  Wenger
7  Zheng Chang

See you in Bangkok!
Booth # B165
Aquafeed – complete solutions from a single source.

Turn to Bühler for one of the most comprehensive lines of aquafeed process technology available anywhere: from raw material handling, cooking and shaping through extrusion to drying and coating of finished products. With an extensive know-how and a passion for quality we ensure not only product uniformity and production efficiency, but also maximum sanitation and safety. Bühler – gentle processing at its best. www.buhlergroup.com/aquafeed

Innovations for a better world.
Pacific white shrimp (*Litopenaeus vannamei*) is one of the most popularly cultured shrimp in the world. The quality and cost effectiveness of commercial feeds are a primary concern for the farmer and feed manufacturer. In order to produce a quality feed one has to understand variations in ingredient cost, quality, and availability. Additionally, the effects of the ingredient on processing, nutrient content of the ingredient and the response of the animal must be understood to make a high quality diet that consistently meets the nutrient requirements of the culture species. Such diets are typically a mixture of a few primary ingredients that produce the desired results. To reduce culture costs, considerable work has been put towards reducing the cost of shrimp feed formulations by replacing relatively expensive ingredients with more economical alternatives. Traditionally, the development of commercial aquatic feeds has been dependent on fish meal (FM) as the main protein source because of its balanced essential amino acid (EAA) profile, high protein content, excellent source of essential fatty acids (EFAs), digestible energy, vitamins and minerals. However, because of high cost and limited availability, feed formulations have shifted to increasing levels of alternative protein sources using limited amounts of fish meal or animal proteins. Among alternative plant protein ingredients, soybean meal is a widely available, economical protein source with relatively high digestible protein and energy contents and good amino acid profile. Several studies have been conducted to evaluate the nutritional value of soybean products in shrimp diets. However, the utilization of soybean meal has limitations because of its moderate protein content and its relatively low level of essential amino acids such as methionine. The low level of methionine often becomes limiting, requiring the blending of other ingredients or the supplementation of synthetic forms. High-protein plant ingredients are being studied as their nutrient density allows for added room in the formulations and if appropriately selected, can complement amino acid profiles of the other protein sources.

Corn Protein Concentrate (CPC) is the dried protein fraction of the corn primarily originating from the endosperm after removal of the majority of the non-protein components by enzymatic solubilization of the protein stream obtained from the wet-mill process. CPC (Empyreal 75, Cargill Corn Milling, Cargill, Inc., Blair, NE, USA), used in the
present study, is high in protein (79.7%) and is a rich source of methionine (1.77%). Despite the common practice of using corn protein products in commercial feed formulations for shrimp, there are few studies evaluating the efficacy of these products.

To evaluate the potential of corn protein concentrate under commercial conditions, four diets were manufactured by Rangen Inc. (Angleton, TX, USA) as a sinking 3-mm extruded pellet (Table 1). Diets contained approximately 36% protein and 10% lipid. The basal diet was designed to contain 15% fish meal which was replaced with graded levels of CPC (0, 4, 8 and 12%). Based on proximate analysis of the diets, the lipid content was significantly higher than the formulated value, which may confound results as lipid levels generally increased with reductions in fish meal.

<table>
<thead>
<tr>
<th></th>
<th>CPC0</th>
<th>CPC4</th>
<th>CPC8</th>
<th>CPC12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal</td>
<td>46.69</td>
<td>46.63</td>
<td>46.48</td>
<td>46.32</td>
</tr>
<tr>
<td>Milo</td>
<td>26.20</td>
<td>26.31</td>
<td>26.48</td>
<td>26.67</td>
</tr>
<tr>
<td>Menhaden Fish Meal</td>
<td>15.00</td>
<td>9.99</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Corn protein concentrate</td>
<td>0.00</td>
<td>4.00</td>
<td>8.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Squid meal</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Menhaden fish oil (sprayed)</td>
<td>4.58</td>
<td>4.86</td>
<td>5.15</td>
<td>5.45</td>
</tr>
<tr>
<td>Soy lecithin</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>Trace mineral premix</td>
<td>0.52</td>
<td>0.52</td>
<td>0.52</td>
<td>0.52</td>
</tr>
<tr>
<td>Stay C 350 mg/kg (35%)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Calcium phosphate dibasic</td>
<td>2.00</td>
<td>2.68</td>
<td>3.36</td>
<td>4.03</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Bentonite</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Mold inhibitor</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Crude Protein</td>
<td>36.38</td>
<td>36.61</td>
<td>36.48</td>
<td>37.68</td>
</tr>
<tr>
<td>Crude Fat</td>
<td>10.28</td>
<td>10.47</td>
<td>13.52</td>
<td>12.91</td>
</tr>
<tr>
<td>Moisture</td>
<td>7.62</td>
<td>7.89</td>
<td>5.15</td>
<td>3.79</td>
</tr>
<tr>
<td>Crude Fiber</td>
<td>2.22</td>
<td>2.18</td>
<td>2.03</td>
<td>2.17</td>
</tr>
<tr>
<td>Ash</td>
<td>10.76</td>
<td>9.60</td>
<td>8.95</td>
<td>8.83</td>
</tr>
<tr>
<td>Lysine</td>
<td>2.44</td>
<td>2.17</td>
<td>2.03</td>
<td>2.00</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.70</td>
<td>0.67</td>
<td>0.68</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Table 1. Ingredient composition (g 100g⁻¹ of feed) of commercially produced open feed formulations and proximate analysis.
The growth trials of post larval *L. vannamei* were conducted under an outdoor pond system conducted at the Alabama Department of Conservation and Natural Resources Marine Resource Division, Claude Peteet Mariculture Center in Gulf Shores, Alabama. Juvenile *L. vannamei* (initial weight of 0.023 g) were collected from a nursery system and stocked in production ponds at the rate of 38 shrimp m$^{-2}$. Ponds used for the grow-out phase were approximately 0.1 ha in surface area, (rectangular 46 x 20 m) with a 1.0 m average depth and lined with 1.52-mm thick high-density polyethylene lining (HDPE). The bottom of each pond was covered with a 25-cm deep layer of sandy-loam soil. All ponds were provided base aeration (about 10 hp ha$^{-1}$) using 1-hp paddlewheels aerators (Little John Aerator, Southern Machine Welding Inc. Quinton, AL) with either 1-hp or 2-hp Aire-O$_2$ aerators (Aire-O$_2$, Aeration Industries International, Inc. Minneapolis, Minnesota) as backup and/or supplemental aeration to maintain dissolved oxygen above 3 mg L$^{-1}$. The additional aerator was used when dissolved oxygen fell below 3 mg L$^{-1}$. This study was developed on a sustainable, semi-intensive system which was well managed.
Four test diets were randomly assigned to 16 production ponds using four replicates per diet. Test diets were divided into two feedings per day, early morning 0800 h and late afternoon 1600 h. Feed inputs were based on previous results from past trials at the facility as well as current observations. A small amount of commercial feed was applied to promote natural productivity in pond water during the first four weeks. Thereafter, feed input was calculated based upon an expected weight gain of 1.3 g wk⁻¹, a feed conversion of 1.2, and a survival of 75% during the pond culture period. The feed input initially started with 7.9 kg ha⁻¹ and increased to a maximum input of 79.7 kg ha⁻¹ after which it was slowly decreased to account for mortality up to week 12. Thereafter, input remained at 76.4 kg ha⁻¹ (Figure 1). Water exchanged was minimized during the trial.

![Figure 1. Feed input calculated based upon an expected weight gain of 1.3 g wk⁻¹, a feed conversion of 1.2, and a survival of 75% during the pond culture period using 0.1 ha ponds.](image)

During the experimental period, shrimp growth was monitored on a weekly basis by sampling 70 to 100 animals per pond. At this time, weights were recorded and the shrimp visually inspected for health. Water quality variables (e.g. dissolved oxygen (DO), temperature, salinity, and pH) were monitored three times a day, at sunrise (0500 h - 0530 h), during the day (1400 h - 1430 h), and at night (2000 - 2100 hr), using a YSI ProPlus meter (Yellow Spring Instrument Co., Yellow Springs, OH, USA). Secchi disk readings and total ammonia nitrogen were monitored on a weekly basis. Water samples were taken from all ponds at a depth of 80 cm in the water column and total ammonia nitrogen was determined using an Orion ammonia electrode probe (Thermo Fisher Scientific Inc., Waltham, MA, USA).

The shrimp were harvested at the end of the 16-week culture period. The night before harvest, water in each pond was drained by about two thirds and aeration was provided using paddlewheel aerators to keep shrimp alive and minimize erosion of the pond bottom. On harvest day, the remaining water was drained and the shrimp were pump harvested from the catch basin using a hydraulic fish pump equipped with a 25-cm
diameter suction pipe (Aqualife-Life pump, Magic Valley Heli-arc and Manufacturing, Twin Falls, Idaho, USA). The pump was placed in the catch basin and shrimp pumped, de-watered and collected in a hauling truck. The shrimp were rinsed and weighed. Approximately 150 shrimp from each pond were randomly selected to measure individual weight and size distribution. The estimated value of the produced shrimp was determined based on the size distribution and the local price for each size class. At the conclusion, mean final weight, net yields, percent survival, and FCR were determined. The results of one replicate from the treatment fed the diet containing 0% CPC and two replicates from the 8% CPC treatment were excluded from the statistical analysis because of low survival of shrimp caused by an oxygen crash and aerator failure.

The four test diets were fed to shrimp under semi-intensive pond production conditions, leading to a final average production of 5,264 kg ha⁻¹ and an FCR of 1.32. These values are typical production values for this facility when shrimp are farmed at around 35-38 individuals per square meter over a 16 week culture period. Growth performance of *L. vannamei* reared under production pond conditions is summarized in Table 2. There were no differences (P > 0.05) in any of the measured production parameters. Yields during the trial were 5440 kg ha⁻¹ (12% CPC), 5421 kg ha⁻¹ (8% CPC), 5190 kg ha⁻¹ (4% CPC), and 5008 kg ha⁻¹ (0% CPC) and no significant differences were observed. Likewise, no significant differences in FCR were observed which ranged between 1.27-1.38 across all treatments. There were also no differences in survival and mean final weight among treatments. Shrimp survival ranged from 64.9% (0% CPC) to 83.6% (8% CPC), and mean final weight ranged from 17.2 g to 20.5 g. The cost of each feed was provided by
the feed mill to allow for the calculation of feed costs per unit of production. Using ingredient and manufacturing costs determined by the feed mill, a production cost ($/kg shrimp) can be calculated. This cost ranged from $1.11 to $1.60 per kg of shrimp produced. As feed costs were different, costs per unit of shrimp were also significantly different (Table 2).

These results demonstrate that the use of alternative plant proteins such as CPC helped to reduce feed cost without significantly reducing yield, therefore reducing overall production costs. Hence, the use of CPC, a protein-rich ingredient having high levels of methionine, should be encouraged as an alternative protein source in commercial shrimp feed formulations.

<table>
<thead>
<tr>
<th>Final weight (g)</th>
<th>Yield (kg/ha)</th>
<th>Survival (%)</th>
<th>FCR (Feed Conversion Ratio)</th>
<th>Production value ($)</th>
<th>Feed Cost ($) / pond</th>
<th>Feed $/Kg Shrimp</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPC0</td>
<td>20.5a</td>
<td>5008a</td>
<td>64.9a</td>
<td>1.38a</td>
<td>2106.72a</td>
<td>791.41a</td>
</tr>
<tr>
<td>CPC4</td>
<td>17.5a</td>
<td>5190a</td>
<td>77.6a</td>
<td>1.34a</td>
<td>1808.40a</td>
<td>715.69a</td>
</tr>
<tr>
<td>CPC8</td>
<td>17.2a</td>
<td>5421a</td>
<td>83.6a</td>
<td>1.27a</td>
<td>1844.05a</td>
<td>651.31c</td>
</tr>
<tr>
<td>CPC12</td>
<td>18.7a</td>
<td>5440a</td>
<td>75.9a</td>
<td>1.29a</td>
<td>2018.08a</td>
<td>598.16d</td>
</tr>
<tr>
<td>PSE</td>
<td>0.5289</td>
<td>117.3565</td>
<td>2.3024</td>
<td>0.03487</td>
<td>65.2261</td>
<td>4.0777</td>
</tr>
<tr>
<td>P-value</td>
<td>0.2112</td>
<td>0.5601</td>
<td>0.1423</td>
<td>0.6898</td>
<td>0.3727</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 2. Growth performance of Pacific white shrimp after 16 weeks of culture in a 0.1 hectare pond. Average initial weight was 0.023 ± 0.002g.

For more information, please contact Dr. D. Allen Davis, School of Fisheries Aquaculture & Aquatic Sciences, Auburn University, AL 36849-5419, USA
Empyreal® 75 is the first and only protein concentrate made from corn. This high-energy, naturally pure protein source provides the nutrition fish need in a highly digestible ingredient. With superior functionality, Empyreal 75 provides even, consistent expansion in extruded feeds and extraordinary binding capacity in pelleted diet applications. And industry experts are drawn to the fact that Empyreal 75 is manufactured in the U.S., bringing with it superior supply assurance beyond any specialized protein ingredient available to the industry.

To learn more, visit e75aqua.com. And be prepared for a whole new perspective on protein.
In order to keep up with the rapid growth of aqua farming, the aquafeed industry is growing at a rate of 11% per year (Tacon et al. 2011). However, the increasing price of feed ingredients together with their limited supply places tremendous pressure to meet the supply demand while remaining cost-effective and competitive. This pressure results in the on-going search for advanced nutritional technologies and/or alternative feed ingredients.

The final quality of a feed is generally determined by how well the feed meets the nutritional requirements of the target species. Naturally, in order for this to be possible, then it is critical to accurately and precisely know the nutrient profiles of the ingredients used. More specifically, it is critical to understand that the value of a certain protein source is based on its amino acid levels, and the availability of those amino acids to support growth of an animal rather than its crude protein level. This is driven by the fact that all species, including aqua, have specific requirements for individual amino acids instead of protein per se. However, despite the need for this information, sufficient data on the amino acid content of many of the unique feed ingredients used in aqua feed is still lacking.

Evonik Industries, a German-based amino acid and feed additive producer, has over 50 years of experience in animal nutrition with specific focus on protein and amino acids. With the largest analytical lab dedicated solely to analyzing the amino acid content of feed ingredients, Evonik provides the most up-to-date data on the amino acid content of raw material used by animal feed industry. Five-year data are compiled and published as AMINODat®, which is considered to be the preeminent source of table values for the amino acid concentrations of most feed ingredients used throughout the world for poultry and swine. However, to address the shortage of quality information on the specific and unique raw materials (e.g., algae, krill meal, squid liver meal, and shrimp head meal) used by the aqua industry, Evonik has now developed AMINODat® Aqua.

AMINODat® Aqua contains over 100 ingredients with the total number of samples analyzed for their total amino acid contents exceeding 9,000. In addition to mean value of individual amino acids, AMINODat® Aqua also provides minimum and maximum value of each amino acid, as well as coefficient of variation, along with number of samples analyzed for each ingredient as illustrated in Table 1 for fish meal (>60% crude protein).
Furthermore, the feed ingredients have been classified under product categories such as cereals, cereal byproducts, brewing and distilling, pulses, oilseeds and meals, animal by-products, amino acids (supplemental sources), forages, milk byproducts, and others (miscellaneous), as well as by continents or region of use and countries of origins wherever possible. AMINODat® Aqua allows the user to rank the ingredients according to the content of a particular amino acid, ratio of essential to nonessential amino acids, lysine content in crude protein or amino acid ratios of the raw material. Additionally, this software provides other options such as import, export, and to create new ingredient data. Finally, nutritionists can evaluate their diet for its amino acid content by using the ration evaluation tool. An example of this is illustrated in the Table 2 using two different diets formulated for pangasius catfish. Diet 1 was formulated using intact protein sources and supplemental methionine, lysine and threonine to meet target levels of commonly limiting essential amino acids (EAA) such as Met (0.80%), Met+Cys (1.10%), Lys (1.70%) and Thr (1.18%). However, when 50% of the fish meal (3 out of 6%) was replaced with corn gluten meal in Diet 2, although dietary crude protein level did not decrease, total lysine level decreased by 0.09% relative to the target level. This is because, although fish meal and corn gluten meal contained similar levels of crude protein (~60%), their profile of EAA particularly for lysine significantly differed. If the diet 2 is fed to fish following only the dietary crude protein content with Lys level below the target requirement, fish growth performances will be reduced. This evaluation tool enables nutritionists to estimate total content of individual EAA for a chosen formulation, compare that to the target level and if needed, balance the dietary amino acid profiles.

### Table 1. Amino acid profile of fish meal (>60% CP, n = 343) from AMINODAT® Aqua

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Mean %</th>
<th>CV %</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lys</td>
<td>4.87</td>
<td>10.6</td>
<td>3.10</td>
<td>5.99</td>
</tr>
<tr>
<td>Met</td>
<td>1.79</td>
<td>10.1</td>
<td>1.00</td>
<td>2.29</td>
</tr>
<tr>
<td>Cys</td>
<td>0.56</td>
<td>15.9</td>
<td>0.33</td>
<td>0.91</td>
</tr>
<tr>
<td>Met+Cys</td>
<td>2.35</td>
<td>10.0</td>
<td>1.68</td>
<td>3.02</td>
</tr>
<tr>
<td>Thr</td>
<td>2.69</td>
<td>8.0</td>
<td>2.05</td>
<td>3.23</td>
</tr>
<tr>
<td>Trp</td>
<td>0.70</td>
<td>11.7</td>
<td>0.46</td>
<td>0.87</td>
</tr>
<tr>
<td>Arg</td>
<td>3.80</td>
<td>9.5</td>
<td>2.65</td>
<td>4.92</td>
</tr>
<tr>
<td>Iso</td>
<td>2.69</td>
<td>9.2</td>
<td>1.85</td>
<td>3.32</td>
</tr>
<tr>
<td>Leu</td>
<td>4.70</td>
<td>8.4</td>
<td>3.32</td>
<td>5.55</td>
</tr>
<tr>
<td>Val</td>
<td>3.15</td>
<td>8.4</td>
<td>2.10</td>
<td>3.84</td>
</tr>
<tr>
<td>His</td>
<td>1.72</td>
<td>23.3</td>
<td>0.95</td>
<td>3.27</td>
</tr>
<tr>
<td>Phe</td>
<td>2.55</td>
<td>7.9</td>
<td>1.82</td>
<td>3.07</td>
</tr>
<tr>
<td>Tyr</td>
<td>1.83</td>
<td>5.5</td>
<td>1.65</td>
<td>2.00</td>
</tr>
<tr>
<td>Gly</td>
<td>4.25</td>
<td>12.9</td>
<td>3.02</td>
<td>6.67</td>
</tr>
<tr>
<td>Ser</td>
<td>2.52</td>
<td>9.7</td>
<td>1.90</td>
<td>3.32</td>
</tr>
<tr>
<td>Pro</td>
<td>2.80</td>
<td>11.3</td>
<td>2.06</td>
<td>4.02</td>
</tr>
<tr>
<td>Ala</td>
<td>4.07</td>
<td>5.7</td>
<td>3.24</td>
<td>4.61</td>
</tr>
<tr>
<td>Asp</td>
<td>5.90</td>
<td>8.2</td>
<td>4.59</td>
<td>7.22</td>
</tr>
<tr>
<td>Glu</td>
<td>8.30</td>
<td>7.8</td>
<td>6.64</td>
<td>10.29</td>
</tr>
<tr>
<td><strong>CP</strong></td>
<td><strong>66.60</strong></td>
<td><strong>5.0</strong></td>
<td><strong>60.00</strong></td>
<td><strong>74.60</strong></td>
</tr>
<tr>
<td><strong>DM</strong></td>
<td>91</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Furthermore, nutritionists can evaluate their diet for its amino acid content by using the ration evaluation tool. An example of this is illustrated in the Table 2 using two different diets formulated for pangasius catfish. Diet 1 was formulated using intact protein sources and supplemental methionine, lysine and threonine to meet target levels of commonly limiting essential amino acids (EAA) such as Met (0.80%), Met+Cys (1.10%), Lys (1.70%) and Thr (1.18%). However, when 50% of the fish meal (3 out of 6%) was replaced with corn gluten meal in Diet 2, although dietary crude protein level did not decrease, total lysine level decreased by 0.09% relative to the target level. This is because, although fish meal and corn gluten meal contained similar levels of crude protein (~60%), their profile of EAA particularly for lysine significantly differed. If the diet 2 is fed to fish following only the dietary crude protein content with Lys level below the target requirement, fish growth performances will be reduced. This evaluation tool enables nutritionists to estimate total content of individual EAA for a chosen formulation, compare that to the target level and if needed, balance the dietary amino acid profiles.
Changes in the dietary amino acid profile of diet 2 versus diet 1 are given in the parenthesis; ‘+’ indicates increase and ‘–’ indicates decrease for a given amino acid.

<table>
<thead>
<tr>
<th>Ingredients, %</th>
<th>Diet 1</th>
<th>Diet 2*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal, CP 48%</td>
<td>28.88</td>
<td>28.88</td>
</tr>
<tr>
<td>Rapeseed meal</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td>De-oiled rice bran</td>
<td>30.21</td>
<td>30.21</td>
</tr>
<tr>
<td>Meat and bone meal</td>
<td>2.23</td>
<td>2.23</td>
</tr>
<tr>
<td>Tapioca</td>
<td>19.33</td>
<td>19.33</td>
</tr>
<tr>
<td>Fish meal, 60% CP</td>
<td>6.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Corn gluten meal, 61% CP</td>
<td>0.00</td>
<td>3.00</td>
</tr>
<tr>
<td>DL-Methionine (MetAMINO®)</td>
<td>0.36</td>
<td>0.36</td>
</tr>
<tr>
<td>L-Lysine Sulphate (Biolys®)</td>
<td>0.35</td>
<td>0.35</td>
</tr>
<tr>
<td>L-Threonine (ThreAMINO®)</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Others</td>
<td>2.49</td>
<td>2.49</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amino acid content %</th>
<th>Target level %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lys</td>
<td>1.70</td>
</tr>
<tr>
<td>Met</td>
<td>0.80</td>
</tr>
<tr>
<td>Cys</td>
<td>0.41</td>
</tr>
<tr>
<td>M+C</td>
<td>1.10</td>
</tr>
<tr>
<td>Thr</td>
<td>1.18</td>
</tr>
<tr>
<td>Trp</td>
<td>0.33</td>
</tr>
<tr>
<td>Arg</td>
<td>1.85</td>
</tr>
<tr>
<td>Ile</td>
<td>1.09</td>
</tr>
<tr>
<td>Leu</td>
<td>1.92</td>
</tr>
<tr>
<td>Val</td>
<td>1.29</td>
</tr>
<tr>
<td>His</td>
<td>0.67</td>
</tr>
<tr>
<td>Phe</td>
<td>1.21</td>
</tr>
<tr>
<td>Tyr</td>
<td>0.71</td>
</tr>
<tr>
<td>Gly</td>
<td>1.45</td>
</tr>
<tr>
<td>Ser</td>
<td>1.22</td>
</tr>
<tr>
<td>Pro</td>
<td>1.39</td>
</tr>
<tr>
<td>Ala</td>
<td>1.35</td>
</tr>
<tr>
<td>Asp</td>
<td>2.61</td>
</tr>
<tr>
<td>Glu</td>
<td>4.25</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>27.38</td>
</tr>
<tr>
<td>Dry matter, %</td>
<td>88.38</td>
</tr>
</tbody>
</table>

Table 2. Diets formulated for grower-stage pangasius catfish to meet target levels of Lys (1.70%), Met (0.80%), Met+Cys (1.10%) and Thr (1.18%) using different combinations of protein sources.
AMINODat® Aqua and all of its features highlighted above provide several key benefits to the aqua industry.

First, it serves as a reference for the nutrient content (amino acids, crude protein) of the most important feed ingredients used in the aqua industry.

Second, it provides average amino acid content as well as a measure of variation for each. This information can be used to establish the value for a particular feed ingredient to steer purchasing and formulation decisions.

Third, the classifications of ingredients will help nutritionists compare ingredients easier as well as have more accurate amino acid data about regionally specific feed ingredients.

Finally, with the ration evaluation tool, nutritionists will be able to quickly assess how their diets rank in comparison to their target levels, which will lead to more consistent and predictable performance.

In summary, AMINODat® Aqua is a unique tool that provides valuable information on the amino acid content of raw materials that can be used by aqua feed industries in order to improve feed quality and profitability.

For more information, please contact Dr. Karthik Masagounder, Technical Sales Manager (Asia South), Health & Nutrition - Feed Additives, Evonik Industries.
Are you ready to take action against food contamination and product recall risk?

Wenger’s food safety and hygienic procedures should play a leading role in your production. Consider just a few of our solutions:

• Corporate Project Services, an entire division dedicated entirely to food safety management systems.

• Equipment with less potential for cross contamination and product accumulation.

• Closed-loop systems and improved product transfer to reduce "fugitive" dust.

• High-Intensity Preconditioner for improved pasteurization and sanitation.

• Machine designs that allow easier cleaning and product inspection.

• Automatic control systems with tracking, traceability and recording.

Contact us now for safety measures customized for your production.

What will tomorrow bring

PROGRESSIVE AQUAFEED PROCESSING
During two feeding trials the potential of poultry oil was examined to partially replace fish oil and/or vegetable oils in trout feed. In a first trial 5% inclusion of poultry oil successfully replaced fish oil. In a successive trial 9% of rapeseed was replaced by 9% of poultry oil with similar technical results. These trials show poultry oil is a valuable, sustainable and economical source of lipids in trout diets.

Fish oil is traditionally the major source of oil in fish feeds. Fish oil is rich in eicosapentanoic acid (EPA) and docosahexanoic acid (DHA). These two fatty acids are essential for optimal growth performance of trout. Vegetable oils do not contain these essential fatty acids EPA and DHA and animal fats contain only negligible amounts. Fish oil is not a sustainable source of oil and is becoming scarce and expensive. Various studies have indicated that fish oil can be partially replaced by other fat or oil sources provided that the diets contain a minimum amount of EPA and DHA for optimal growth performance.

Fatty acid profile

The needs for EPA and DHA depend on the fish species and it is well studied that marine fish have higher needs for these highly unsaturated fatty acids than fresh water fish. Besides the real needs for the fish, also the final quality of the fish product is important considering human health and organoleptic properties (taste). Therefore, a lot of research effort has been done on restoring the fatty acid profile to a high PUFA profile in the last phase of fish production as if they were cultured the whole cycle on fish oil.
The apparent digestibility (ADC) of dietary lipid can be primarily explained by the ratio of saturated fatty acids (SFAs) to total fatty acids and can be incorporated in diets at levels below 23% without negatively affecting lipid digestibility for a wide variety of fish species. Based on present knowledge, the use of high oleic acid oils, such as poultry and rapeseed oil, is recommended rather than a soybean type because they provide oleic acid rather than linoleic. With oleic acid being one of the predominant fatty acids in olive oil which is recognized as an important component of the Mediterranean diet, it can be related to positive effects on coronary heart diseases. Besides, the relatively low content of linoleic acid in poultry oil will limit the effects on the n-6 / n-3 maximum ratio, an important limiting factor in fish feed formulations.

**Replacement of fish oil by poultry oil**

Juvenile female rainbow trout of 35 grams was fed with (1) a diet with exclusively fish oil, (2) a diet with 5% poultry oil at the expense of fish oil, and (3) a diet with 5% poultry oil at the expense of fish oil for the first half of the study (28 days) and with a diet with exclusively fish oil for the second half of the study (28 days). The diets contained 45% protein and 21% fat and half of the total protein in the diets was derived from fishmeal.

Feeding the diets for 42 days did not result in any differential effects of the various diets on the growth performance parameters. However, feeding the diets for another 2 weeks (total of 56 days on diet) resulted in slight differences in growth performances between
the various dietary groups. Fatty acid analysis of the trout at the end of the study (56 days on diet) indicated that feeding the poultry oil resulted in somewhat lower EPA and DHA levels and higher oleic and linoleic acid levels compared with the trout fed exclusively fish oil. The trout of the dietary group that had been fed the poultry oil during the first 28 days of the experiment and the fish oil during the second 28 days of the experiment, had EPA and DHA levels intermediate between the poultry oil and the fish oil group. Organoleptic test done by a taste panel suggested that there was no difference in organoleptic properties of the flesh of the trout fed the 3 dietary regimens. 1.41 kg of fish oil in the diets with exclusively fish oil is needed to generate 1 kg of oil in the fish raised whereas about 1.06 kg of fish oil in the diets with 5% poultry oil (24% of total oil in the diets) is needed to generate 1 kg of oil in the fish raised. Thus, the inclusion of only 5% poultry oil in the diets resulted in a considerable conservation of fish oil.

Replacement of rapeseed oil by poultry oil

Juvenile female rainbow trout was fed with diets containing either 9% rapeseed oil or 9% poultry oil. The diets contained 44% protein and 20% fat. 50% of the total protein in the diets was derived from fishmeal and 50% of the total oil in the diet was derived from fish oil.

Feeding the diets for 58 days did not result in any statistically different effects of the oils in the diets on the various growth performance parameters. 0.75 kg fish oil was needed for the trout fed on the 9% rapeseed and 9% poultry oil diets to generate 1 kg oil, whereas 1.37 kg

“Poultry oil is a high quality lipid source for many fish species and a good candidate to (partly) substitute fish oil or other sources of fatty acids”
fish oil would be needed to generate 1 kg of oil when exclusively fish oil would be incorporated into the diets. Thus the inclusion of 9% poultry oil in the diet resulted in a considerable conservation of fish oil.

**Poultry oil, a valuable source of lipids in trout diets**

The above trials demonstrated the successful inclusion of poultry oil in trout diets. Poultry oil is a high quality lipid source for many fish species and a good candidate to (partly) substitute fish oil or other sources of fatty acids. The inclusion level depends on numerous factors, such as the fatty acid profile of the alternative lipids used, the fish species and the phase of the production cycle. Taking into account these factors, poultry oil is a valuable, sustainable and economical source of lipids in aqua feed formulations.

---

**Sustainable ingredient for aqua feed**

- High digestible energy content
- Sustainable (Carbon footprint analysis data available on request)
- High nutritional value
- Cost effective

---

Please visit us at VIV Europe 2014: Hall 8, stand E71
Sanitary Design Cooler
For highest food safety standards

Geelen Counterflow Holland
Geelen Counterflow USA
Geelen Counterflow Argentina
Geelen Counterflow China

info@geelencounterflow.com
www.geelencounterflow.com
An overview of the feeding management of farmed tilapia throughout the culture cycle

By Wing-Keong Ng, PhD and Nicholas Romano, PhD

Fish Nutrition Laboratory, School of Biological Sciences, Universiti Sains Malaysia, Penang 11800, Malaysia

Introduction

Tilapia is now the second most farmed fish in the world with a production of over 3 million metric tons/year and is farmed in more than 100 tropical and sub-tropical countries (Figure 1). China is the major producer of tilapia, most of which is Nile tilapia. While the United States contributed less than 0.5% of global production, their imports make up about 92% of global exports. There are also indications that Europe will increasingly adopt tilapia as an alternative to traditional white fish species. The current worldwide sales of tilapia have risen to over US$5.0 billion annually.

Apart from many beneficial characteristics that include their tolerance to crowding, high marketability, relative ease of captive spawning year-round, high disease resistance and success with polyculture, the rapid increase in the global production of tilapia has been due in great part to the increased use of formulated feeds based on an increased

![Figure 1: Top producers of Nile tilapia (left) and other tilapia species not including Nile tilapia (right) based on data from Food and Agriculture Organization, United Nations. Diagram from Ng and Romano (2013).]
understanding of their nutritional requirements as well as better feeding management strategies. It has been estimated that more than 85% of global tilapia production is currently based on the provision of commercial pelleted feeds. Research advances in the use of cheaper and more sustainable terrestrial-based resources compared to the conventional fishmeal and fish oil marine-based ingredients in tilapia feeds have contributed much in making this farming industry more cost-competitive and profitable. This underscores the importance of appropriate nutrition and feeding management since feeding cost is often the most expensive operation costs in a modern tilapia farm. However, identifying the most appropriate ingredient type, methods to improve their utilization, and appropriate feeding strategies are still crucial to optimize productivity. With the use of more plant-based ingredients, there will be a greater focus on developing and relying on feed additives and supplements to ensure that the nutritive value of the diets are not compromised. Feeding strategies to ensure that the health benefits of tilapia products for the human consumers are maintained are also essential in modern tilapia farming. There is also an increasing need to better understand the nutritional requirements of fast growing improved strains of tilapia so that their inherent genetic potential for growth is fully optimized. Some of the practical issues related to nutrition and feeding of tilapia at each stage of their culture cycle will be briefly discussed in this article.

Global tilapia production is increasingly coming from industrial scale farms using advanced and intensive farming techniques as well as a complete dependence on manufactured feeds.
Practical feed management throughout the culture cycle

The most effective feeding management strategy is greatly dependent on the life stage of tilapia (Figure 2). It is known that the nutritional requirements change depending on the life stage of tilapia while different feeding regimes and feed formulations can also have a significant effect. Tilapia species of commercial value are mouth-brooders with asynchronous spawning cycles as well as low fecundity that decreases over time, and these characteristics are viewed as major limitations to the continued expansion of commercial tilapia farming. It is well known that nutrition plays a vital role in fish fecundity and while it has been stated that commercial feeds designed specifically for tilapia broodstock are unavailable due to a perceived lack of demand, this appears to be slowly changing over the past decade due to the increasing demand for high quality fry for stocking tilapia production systems. Compared to the nutrient requirements of tilapia during the grow-out stages, information on broodstock nutrition is still lacking. Generally, higher protein levels with a protein to energy ratio of 20 to 24 mg crude protein KJ/g have been recommended. Lipid sources with higher levels of omega-6 polyunsaturated fatty acids and high dietary levels of vitamin E have also been reported to benefit reproductive performance in tilapia. Using a lower feeding rate for broodfish will likely provide a variety of benefits including lower feeding costs and minimizing nitrogenous waste production, which is particularly beneficial to reduce fouling in hapa systems used for tilapia breeding. Moreover, if feed is provided in excess leading to higher growth rates of broodstock, this may become undesirable since larger fish have higher feed intake rates, lower relative fecundity and more difficult to handle when removing eggs from their

Figure 2: The culture cycle of farmed tilapia. Fish stages are not drawn to scale (modified from Ng and Romano, 2013).
mouthe for subsequent incubation.

Upon hatching, the tilapia fry initially rely on their yolk reserves, but this can be quickly used up. To support their fast growth and minimize cannibalism, farmers often use better quality feeds with higher protein levels, and more frequent feeding rates during the fry stages than during their grow-out stages (Figure 3). High protein diets (40-50%) fed frequently (six times per day) at 30-45% body weight or to satiation are often used at this culture stage. Nevertheless, it is also possible to reduce feeding costs by alternating high and low protein diets, since this have little impact on their growth. At this life stage, feeding management can be a highly effective tool to meet seasonal market demands for tilapia fry. This may be done by purposely stunting the growth of fry or fingerlings by higher stocking densities and reducing feeding rates. Since male tilapia grow faster than females, the production of all male tilapia populations is often practiced in commercial hatcheries. During the fry stages, the use of synthetic male steroid, methyltestosterone (MT), in the feeds is the most commercially used method to sexually reverse females. This male hormone must be provided before, during and after their sexual differentiation and therefore the duration of treatment, fry sizes as well as dose are crucial to success. To provide this treatment prior to the onset of sexual differentiation, the best results are when fry sizes are at \( \leq 11 \) mm for a period of 28 days with a dose of 60 mg MT/ kg of feed.

The protein, amino acids, lipid, fatty acids, energy, vitamins and minerals requirements of tilapia have been well researched and recently reviewed by Ng and Romano (2013). However, it should be pointed out that most of these data comes from laboratory-based studies involving fish fingerlings. While these data can be adapted for use in the formulation of fingerling and grow-out feeds, the relevance to larval and broodstock feeds are somewhat limited. It should also be noted that the role and contribution of nutrients, especially vitamins and minerals, available in the culture environment as well as endogenously found in the feed ingredients used in tilapia feeds remains mostly unknown. We also believe that many of these published nutrient requirements for tilapia will have to be eventually revised with the increasing farming of fast-growing improved strains of tilapia in order for these tilapia strains to achieve their full genetic potential for growth.

![Figure 3: The recommended feeding rate (% body weight), feeding frequency and pellet size (mm) of tilapia based on their weight (g). Modified from Ng and Romano (2013).](image-url)
Generally, to protect their intellectual property, feed companies do not reveal the exact nutrient and ingredient composition of commercial fish feeds. Commercial tilapia feeds are commonly grouped as pre-starter, starter, grower or finisher feeds with each feed group sometimes sub-divided further depending on quality or feed additives used. It is worthwhile to note that not only are different protein levels preset for each life stage but also the maximum acceptable inclusion level of alternative protein sources are concomitant with tilapia development. The use of ingredients can also vary widely depending on the country. For example, up to 60% of soybean meal (SBM) and 30% rice bran are used in Vietnam as a protein and carbohydrate source, respectively, while in China, protein can be in the form of SBM, cotton seed meal or rapeseed/canola meal with maize, wheat and grain serving as carbohydrates. Most tilapia farming countries are advocating and promoting the use of locally sourced feed ingredients and agricultural by-products to reduce feeding costs. Currently the most popular fishmeal alternatives in commercial grow-out tilapia feeds include SBM, canola/rapeseed meal and cottonseed meal. In fact, SBM has now become the major protein source used in tilapia feeds and this ingredient is becoming more costly. However, a common problem to these and other plant-based protein sources is a deficiency in one or more amino acids required by tilapia. Moreover, there are certain compounds that may affect their growth, health and nutrient utilization known as "anti-nutritional" factors. These may be highly specific to the plant ingredient. For example, SBM contains a potentially toxic compound called phytate, which not only binds to protein and minerals (thus making them less available), but may also harm the internal organs of tilapia. To mitigate these drawbacks, pre-treating ingredients with enzymes or heat may be beneficial as well as supplementations of minerals and amino acids.
acids. Research is continuing in this area with promising results. The combined use of several alternative protein sources to totally replace dietary fishmeal instead of single protein sources has also been successful in tilapia feeds without the need for additional dietary supplementations.

Fish oil alternatives can include soybean oil, canola oil, linseed oil or various palm oil fractions. Some research have reported that the sole use of fish oil as lipid source in tilapia feeds can actually reduce tilapia growth while the above mentioned fish oil alternatives can be used with good success. Moreover, in some cases such as palm oil products, this can actually improve broodstock reproductive performance. However, since these plant-based oils do not contain omega-3 long chain polyunsaturated fatty acids, the final fillet product will contain lesser amounts of these health-beneficial fatty acids for human consumers. Subsequently, there has been increasing research attention in the use of “finishing diets” prior to harvest that can enhance their fillet lipids omega-3 long chain polyunsaturated fatty acid composition.

Conclusion

Understanding the nutritional requirements of tilapia throughout their culture cycle and implementing the most appropriate feeding management strategy is important to produce a higher quality product cost-effectively. While the protein and amino acid requirements of tilapia are generally well known and studied, the fatty acid and some vitamin/mineral requirements are less well understood including contradictory results which represents major gaps that require further investigations. Indeed, perhaps some of contrasting findings among studies may be due to complex interactions among various ingredients or even genetics that can influence their utilization. In the case of the latter, this will likely become increasingly important to understand and quantify since there are indications that improved strains utilize nutrients differently which may require specific dietary formulations for their full genetic potential to be realized. Through focused efforts and research, it is entirely possible to improve tilapia production in a sustainable way to meet the increasing demand for tilapia products.

Increasingly, more and more countries are implementing standards and specifications for formulated tilapia feeds where the composition and physical properties of these feeds are regulated by law to ensure that the feed companies comply. This often includes a list of prohibited chemicals, antibiotics, feed ingredients and other substances. Most tilapia farming countries now have feed regulations that control the manufacture, import and distribution of tilapia feeds. The right mix of science, farm management strategies and governmental policies will ensure the continued sustainability and scalability of the global tilapia industry.

For a comprehensive overview, refer to Ng and Romano, A review of the nutrition and feeding management of farmed tilapia throughout the culture cycle, which was published in the December 2013 issue of Reviews in Aquaculture 5, 220-254.

For more information, please contact: Wing-Keong Ng, PhD, Fish Nutrition Laboratory, School of Biological Sciences, Universiti Sains Malaysia, Penang 11800, Malaysia

Professor Wing-Keong Ng will be discussing his latest results on work with organic acids as a functional feed additive in the commercial feeds of tilapia and marine shrimp at Aquafeed Horizon Asia 2014, Bangkok, April 8, 2014.
MUYANG
SINGLE SCREW EXTRUDER
High-efficient extruder for aquafeed, food, petfood and raw material treatment
Sinking/floating aquafeed in particular.

TAILORED SOLUTION
YOUR FIRST CHOICE

High efficiency
DCD conditioner and optimal extruder screw & chamber, minimum SME input; energy recovery, maximum energy utilization; unique suspending cutter, replacement and adjustment without downtime.

Wide production range
Controllable temperature, pressure and density with modularized design and many add-ons, minimizing reconfiguration acquired.

Simple operation
Leading extrusion technology and intelligent control by-pass to avoid blockage; simple operation, precise and reliable.

Customizable solution
Including machine size, screw, discharge die, cutter knives, pipeline and energy recovery system etc.

Satisfying product quality
Uniform pellets with high fat absorption, unique visual appearance.

VALUE-ADDED SUPPORT
Know-how and expertise sharing
Plants design, construction, installation and start-up
Advice and training
Customer service

MUYANG GROUP
Add. No. 1/Muyang Rd., Yangzhou, Jiangsu, China 225127
Tel: +86-514-87648880  Fax: +86-514-87648889
E-mail: muyang@public.yz.js.cn
www.muyang.com
Adifo celebrates its 40th anniversary

Double interview: Two generations of specialists in the feed and aquafeed industry

Founder and former CEO Piet De Lille, and current R&D manager Reinhart De Lille, father and son, give their personal views on 40 years of Adifo. Which milestones have the feed and aquafeed industry already reached and, above all, what does the future hold?

Left: Piet De Lille, founder and former Adifo CEO; Right: Reinhart De Lille, R&D manager at Adifo.

It is an amazing achievement for a software company to remain in the market for 40 years. To what does the company owe this achievement?

Piet: It all comes down to making the right strategic choices and maintaining a particular vision. Adifo has always been a highly customer-focused company. I’m no computer expert, but I could strongly identify with the strategy of a company, and because of this I was able to design programmes with added value for the organisations. I founded Adifo with my parents in 1974, after obtaining my degree electromechanics. In the early days we mainly supplied solutions for bookkeeping, invoicing and salary administration. Even at that time, we were already very conscious of the functional aspect of the services we provided. We examined customers’ needs and responded accordingly. We did a great deal of customized work, mainly for trade unions and medical laboratories. Later on, we also did this for construction firms and trading companies and approximately ten years later chose to specialise in the feed and aquafeed industry.

Reinhart: Indeed, our customer focus and specialisation have always been strong assets. The significant amount of customized work has since been configured in standard packages that serve a broad range of applications. Moreover, our technological choices have been decisive for our continuity. Adifo has always striven to choose the right platform for developing
software in order to be able to guarantee continuity to our customers. A large portion of our resources are used for product development, vision and technology. And this is certainly a decisive factor in our success.

How has available technology influenced Adifo’s evolution?

Piet: the evolution from room-sized computers with punch cards or tape streamers to cloud services is spectacular to say the least. In the last 40 years we have developed our software on different platforms. We have always been advocates of open-source technology, enabling us to develop our software independently from hardware suppliers and thus guaranteeing continuity for our customers.

Reinhart: The last decade, the market continued to evolve quickly, and so did Adifo. In 2008, we chose resolutely for Microsoft, particularly because it is an open system. Microsoft gives users a central position, rather than processes, and that is precisely Adifo’s philosophy! We pride ourselves on added value and user-friendliness. We decided to stick with our core business and provide added value in a standard package. This is also the reason why we chose to develop our ERP package on the Microsoft Dynamics AX platform. The combination of an industry
standard with our sector knowledge is highly successful. And now there is naturally the cloud. It’s an amazing technology, making optimal knowledge exchange possible for our ‘Formulation as a Service’ package.

Why did you actually decide to specialize in the feed and aquafeed sector?

Piet: I was always interested in the sector. As a child I preferred to spend my time on neighbours’ and friends’ farms. I also found the emergence and the evolution of the feed market absolutely fascinating. How in the post-war years, food shortages were relieved with imports from the United States and South America. The storage of huge quantities of raw materials around European seaports. The development of the futures market, the spot market and the by-products market. How the feed market suddenly became a booming business. It was all extremely interesting.

Adifo was experienced in goods flows and the entire logistics process, as well as financial administration. From then on, we chose resolutely to work for this market segment, and we still do today.

Adifo’s software is used in over sixty countries. How was this international growth achieved?

Piet: In the first instance we owe this to the Dutch, who are agricultural pioneers. Our Dutch customers also used our software in their branches abroad. Reinhart: Because BESTMIX offers a broad range of applications, can expand flexibly with the company and is available in numerous languages, it is now used in over sixty countries. Borders no longer exist with the current cloud applications, paving the way for global use of our industry standard package.

What are the greatest challenges facing the feed and aquafeed industry?

Piet: The biggest challenge for each company is finding its right place in the market segment. Volatile raw materials prices, fluctuations in quality, dealing with market speculation, determining the right strategy (what to purchase, what to stock, what to use oneself and what to sell). These represent ongoing challenges for the sector. In addition, scale and internationalization should not be underestimated.

Agricultural raw materials contain content values that can be valued differently than the compound product for each of these sectors. What was once waste for one is now a by-product for another. In order to meet the increasing demand for food, we must be as economical with the available raw materials as possible. In the aquafeed sector, Multiblend and Milas AX can be used to determine the perfect future purchasing positions and then the logistics flow can be made efficient.

Reinhart: It’s true, the greatest challenge for the future lies in feeding the growing world population. By 2050, nine billion people will inhabit the earth. They will all have to be fed, but in a sustainable manner in which waste flows and the carbon footprint are kept as low as possible. Sustainability has become a genuine buzzword. Social habits are also changing. In the 1980s, many women suddenly joined the labour market, which meant that convenience foods became extremely popular. With current questions about healthy eating fresh from nature, ready-made meals are viewed in a different light. Animal welfare and GMOs are also highly sensitive issues. The question is whether major changes in food patterns can be identified. These appear to be less spectacular than one would expect. But who plays the most
decisive role? The consumer or the producer? This market dynamic is absolutely fascinating and presents the food industry with major challenges. Technology is constantly advancing too. Nutritional values that can be quickly calculated using a mobile phone app, and all available information that can be shared in real time with business partners and consumers, providing an optimal user experience: these are aspects that we are currently looking into.

What does the future hold for Adifo?

Reinhart: Adifo will stick with its specialization and continue to develop it using industry-standard technology. We will continue to be a fan of open technology and give user-friendliness and the user experience a central position in our services. The market will become increasingly open and new cloud applications will be developed. If you talk about openness you must also be open as a company. Therefore, for example the FaaS and MILAS-AX platform will be opened up so that partners and major parties will be able to integrate and expand it with their applications.

Adifo will also increase its international operations. In specific terms this means that we will intensify our activities in China and the US. In any case, we operate in a fascinating world and are looking forward to the future with great enthusiasm.
AQUAFEED HORIZONS ASIA 2014
April 8. 2014, BITEC, Bangkok

Aquafeed.com is proud to present the popular international conference "Aquafeed Horizons Asia" once again during FIAAP & VICTAM 2014. The 7th in the series will focus on advances in formulation and processing that offer practical solutions to commercial aquafeed companies in terms of production efficiency, quality improvement and profitability.

The conference language is English with simultaneous Thai interpretation

Special rates are available for early registration, combined registration with FIAAP conference, students, for Thai delegates and for groups of three or more people registering at the same time.

*PROGRAM

Ingredients & Formulation
Novacq – Commercializing the paradigm shift in shrimp nutrition
Dr. Matthew Briggs, Ridley AgriProducts Pty. Ltd., Australia

Least cost diets are for suckers – economic formulations for 2020
Dr. Richard Smullen, Ridley AgriProducts Pty. Ltd., Australia

Protease in aquaculture feed - better quality, better profit or both?
Dr. M A Kabir Chowdhury, Jefo Nutrition Inc., Canada

Functional feed additives to reduce the impact from bacterial diseases on shrimp production
Dr. Peter Coutteau, Nutriad International NV, Belgium

Organic acids as a functional feed additive in the commercial feeds of tilapia and marine shrimp
Professor Wing-Keong Ng, FASc

Processing Technology
High capacity and cost efficient aquafeed production
Finn Normann Jensen, Andritz Feed & Biofuel, Denmark

Improving aquafeed buoyancy and pellet uniformity with density controllers and revolver die
Cristian Atienza, Bühler, Switzerland

Single use or multiple purpose extruder designs
Joseph P. Kearns, Wenger Manufacturing, USA

Process and technology considerations for efficient drying of aquafeed of varying sizes
Dan Poirier, Bühler Aeroglide, Switzerland

Pre registration closes April 1— Reserve your place now!!!

feedconferences.com

An Aquafeed.com conference

SPONSORED BY

AQUAFEED HORIZONS ASIA 2014
April 8. 2014, BITEC, Bangkok

Aquafeed.com is proud to present the popular international conference "Aquafeed Horizons Asia" once again during FIAAP & VICTAM 2014. The 7th in the series will focus on advances in formulation and processing that offer practical solutions to commercial aquafeed companies in terms of production efficiency, quality improvement and profitability.

The conference language is English with simultaneous Thai interpretation

Special rates are available for early registration, combined registration with FIAAP conference, students, for Thai delegates and for groups of three or more people registering at the same time.

*PROGRAM

Ingredients & Formulation
Novacq – Commercializing the paradigm shift in shrimp nutrition
Dr. Matthew Briggs, Ridley AgriProducts Pty. Ltd., Australia

Least cost diets are for suckers – economic formulations for 2020
Dr. Richard Smullen, Ridley AgriProducts Pty. Ltd., Australia

Protease in aquaculture feed - better quality, better profit or both?
Dr. M A Kabir Chowdhury, Jefo Nutrition Inc., Canada

Functional feed additives to reduce the impact from bacterial diseases on shrimp production
Dr. Peter Coutteau, Nutriad International NV, Belgium

Organic acids as a functional feed additive in the commercial feeds of tilapia and marine shrimp
Professor Wing-Keong Ng, FASc

Processing Technology
High capacity and cost efficient aquafeed production
Finn Normann Jensen, Andritz Feed & Biofuel, Denmark

Improving aquafeed buoyancy and pellet uniformity with density controllers and revolver die
Cristian Atienza, Bühler, Switzerland

Single use or multiple purpose extruder designs
Joseph P. Kearns, Wenger Manufacturing, USA

Process and technology considerations for efficient drying of aquafeed of varying sizes
Dan Poirier, Bühler Aeroglide, Switzerland

*Program subject to change

Pre registration closes April 1— Reserve your place now!!!

feedconferences.com

An Aquafeed.com conference

SPONSORED BY
In the autumn 2013 edition of *Aquafeed*, Dr. Nabil Said of Insta-Pro International discussed the new MS3000 Medium Shear Extruder for making high-quality, shaped, aquafeed pellets (see *Aquafeed*, autumn 2013, volume 5, issue 3, pages 41-45). In it, he described the market conditions that led to the development of a low cost, easy to operate, and rugged equipment solution for small to medium scale fish feed producers. Also mentioned is that the new MS3000 Medium Shear Extruder is based upon existing high shear extrusion technology.

Current market conditions in the aquafeed industry have renewed interest in using high shear, dry extrusion to recycle aquatic co-products for use in fish diets. This is important for several reasons. The aquaculture industry is rapidly growing around the world, and the demand for fish meal (a major ingredient in aquafeeds) is increasing. This is shown by the increase in the price of fish meal, which was $480 per ton in 2001, and is now over $2,000 (1). There is no indication that this trend will change anytime soon, as wild-caught fish (typical source of fish meal) levels have remained flat for decades (2). As shown in (2), fish production from aquaculture continues to grow, and co-products that result from farmed fish processing could serve to fill some of this void.

Dry extruders have been used for decades to turn what would have been fish waste into high-quality ingredients for aquaculture diets. For example, Robinson et al. (3) worked with dry extruded soybean - fish co-product mixes. The purpose of the research was to replace menhaden and catfish fish meals with the extruded soy/fish co-products, and to determine if they could be used to support catfish performance during a feeding trial. Mixtures of defatted soy and dehulled, full-fat soybeans were used alone, or in combination with liquid fish (hydrolyzed catfish offal) or catfish scrap. These protein sources were extruded with an Insta-Pro 2000
extruder, and used in catfish diets to replace traditional fish meals. A catfish feeding trial was then conducted, and the growth responses to these recycled protein sources are shown below.

The result from a typical catfish diet is shown on the far left bar. Solvent-extracted soybean meal and menhaden fish meal made up the majority of the protein in this diet, and supported the least amount of catfish growth. When extruded soy (both defatted and dehulled, full fat) and catfish meal were the main protein sources, catfish growth was maximized (far right bar). Most of the improved growth performance appeared to be due to the extruded soy, as catfish meal had a lower protein efficiency ratio than menhaden fish meal (3). The extruded soy and menhaden fish meal had very similar protein efficiency ratios (3). Therefore, extruded soy contained high-quality protein when in catfish feed, which was shown when it was used alone (second bar from left) and nearly able to support the growth performance of extruded soy and fish meal (far right bar).

Incorporating fish co-products into soy before extrusion produced different results. Liquid fish was inferior to catfish scrap in terms of supporting weight gain (middle and middle-right bars above). As all of the diets in the growth study were formulated to contain identical total energy and protein levels, liquid fish likely contained lower levels of digestible amino acids than catfish scrap. This result demonstrates the importance of formulating fish diets on a digestible, rather than total, basis, and on having quality, well-defined supplies of raw materials. It may be necessary to comingle or test incoming raw materials, especially if several sources are used, to maintain consistent performance results. As the price of fish meal continues to stay elevated, or rise further, it may well be worth the effort.

High shear, dry extrusion has been used similarly with other aquatic co-products, such as
shrimp heads and squid viscera (4). In addition, dry extrusion, when done properly, is effective at sterilizing co-products with notable microbial loads, such as poultry mortalities and hatchery waste (5).

Therefore, as small to medium fish feed producers turn to the new MS3000 Medium Shear Extruder for quality production at the right price, they may also consider recycling fish co-products to save on the high costs of fish meal. High shear extruders are not only the foundation of the MS3000 Medium Shear Extruder, but now more than ever allow fish farmers and fish feed producers to lower production costs.

For more information, please contact Dr. Dave Albin, Applied Nutrition Technologist, Insta-Pro International, USA.

**References**

1. Fish meal prices to remain prohibitively high for pig, poultry feeds, Ioannis Mavromichalis, PhD, Watt Ag Net
2. Global total fish harvest, Wikipedia
Exhibition & Conferences for feed ingredients, additives and formulation

8 – 10 April 2014 · Bangkok International Trade & Exhibition Centre (BITEC), Bangkok, Thailand

Asia’s premier aquafeed event

Specialist conferences
The exhibitions will be supported by their own specialist conferences. They will include:
Aquafeed Horizons Asia 2014
The FIAAP Conference 2014
The Thai Feed Conference 2014

Supported by
The Thailand Convention and Exhibition Bureau

Co-located with
GRAPAS Asia 2014
www.grapas.eu

Contact details
For visitor, exhibition stand space and conference information please visit:
www.fiaap.com or www.victam.com
Occurrence of Deoxynivalenol and Zearalenone in Commercial Fish Feed: An Initial Study

Abstract

The control of mycotoxins is a global challenge not only in human consumption but also in nutrition of farm animals including aquatic species. Fusarium toxins, such as deoxynivalenol (DON) and zearalenone (ZEN), are common contaminants of animal feed but no study reported the occurrence of both mycotoxins in fish feed so far. Here, we report for the first time the occurrence of DON and ZEN in samples of commercial fish feed designed for nutrition of cyprinids collected from central Europe. A maximal DON concentration of 825 μg kg⁻¹ feed was found in one feed whereas average values of 289 μg kg⁻¹ feed were noted. ZEN was the more prevalent mycotoxin but the concentrations were lower showing an average level of 67.9 μg kg⁻¹ feed.

Pietsch, Constanze; Kersten, Susanne; Burkhardt-Holm, Patricia; Valenta, Hana; Dänicke, Sven. 2013. "Occurrence of Deoxynivalenol and Zearalenone in Commercial Fish Feed: An Initial Study." Toxins 5, no. 1: 184-192.

Full paper
Effect of Replacing Dietary Fishmeal with Soy-Based Products on Production Performance of Near Commercial Size Cobia, Rachycentron canadum

Abstract

Fish meal replacement experiment was conducted with cobia above 1.77 ± 0.3 kg. The fish were fed one control diet and three experimental diets, for duration of 91 days. All diets were formulated isonitrogenous and isoenergetic and supplemented with amino acid mix. The control diet was similar to commercial diet formulations. Two experimental diets were formulated in which 67% of protein from fishmeal was replaced by: a) a combination of dehulled SBM+ Soy Protein Concentrate (Solae Profine®) labeled as MXSB diet, and b) a combination of Soy Protein Concentrate (Solae Profine®) + Schillinger Navita™ labeled Navita™ diet. In the Navita™ diet, the Soybean meal was completely replaced by SG-Navita™. The final experimental diet was formulated to replace 80% of protein from fishmeal by a combination of Schillinger Navita™+ Soy Protein Concentrate (Solae Profine®) labeled Navita™ Extreme diet. Results showed no significant differences between all four diets in most performance criteria (FCR, PER, FE, MDI, GPI, and GEI). Data also showed no significant differences in MR, VSI, and HSI. These results concluded that no physiological alterations occurred when fish were feed high levels of soy-bean replacement diets. There existed significant differences in FIFO ratios between diets. Data showed that Navita™ extreme produced the lowest values, which reached as low as 0.91 ± 0.16. Our findings suggest that Navita™ has a high potential to serve as a fishmeal replacement in aquaculture feeds.

Tudela, Carlos E., "Effect of Replacing Dietary Fishmeal with Soy-Based Products on Production Performance of Near Commercial Size Cobia, Rachycentron canadum"

Full paper

Readily Available Sources of Long-Chain Omega-3 Oils: Is Farmed Australian Seafood a Better Source of the Good Oil than Wild-Caught Seafood?

Abstract

Seafood consumption enhances intake of omega-3 long-chain (≥C20) polyunsaturated fatty acids (termed LC omega-3 oils). Humans biosynthesize only small amounts of LC-omega-3, so they are considered semi-essential nutrients in our diet. Concern has been raised that farmed fish now contain lower LC omega-3 content than wild-harvested seafood due to the use of oil blending in diets fed to farmed fish. However, we observed that two major Australian farmed finfish species, Atlantic salmon (Salmo salar) and barramundi (Lates calcarifer), have higher oil and LC omega-3 content than the same or other species from the wild, and remain an excellent means to achieve substantial intake of LC omega-3 oils. Notwithstanding, LC omega-3 oil content has decreased in these two farmed species, due largely to replacing dietary fish oil with poultry oil. For Atlantic salmon, LC omega-3 content decreased ~30%–50% between 2002 and 2013, and the omega-3/omega-6 ratio also decreased (>5:1 to <1:1). Australian consumers increasingly seek their LC omega-3 from supplements, therefore a range of supplement products were compared. The development and future application of oilseeds containing LC omega-3 oils and their incorporation in aquafeeds would allow these health-benefitting oils to be maximized in farmed Australian seafood. Such advances can assist with preventative health care, fisheries management, aquaculture nutrition, an innovative feed/food industry and ultimately towards improved consumer health.


Full Paper

Fish Oil Replacement in Current Aquaculture Feed: Is Cholesterol a Hidden Treasure for Fish Nutrition?

Abstract

Teleost fish, as with all vertebrates, are capable of synthesizing cholesterol and as such have no dietary requirement for it. Thus, limited research has addressed the potential effects of dietary cholesterol in fish, even if fish meal and fish oil are increasingly replaced by vegetable alternatives in modern aquafeeds, resulting in progressively reduced dietary cholesterol content. The objective of this study was to determine if dietary cholesterol fortification in a vegetable oil-based diet can manifest any effects on growth and feed utilization performance in the salmonid fish, the rainbow trout. In addition, given a series of studies in mammals have shown that dietary cholesterol can directly affect the fatty acid metabolism, the apparent in vivo fatty acid metabolism of fish fed the experimental diets was assessed. Triplicate groups of juvenile fish were fed one of two identical vegetable oil-based diets, with additional cholesterol fortification (high cholesterol; H-Chol) or without (low cholesterol; L-Chol), for 12 weeks. No
effects were observed on growth and feed efficiency, however, in fish fed H-Col no biosynthesis of cholesterol, and a remarkably decreased apparent in vivo fatty acid β-oxidation were recorded, whilst in L-Chol fed fish, cholesterol was abundantly biosynthesised and an increased apparent in vivo fatty acid β-oxidation was observed. Only minor effects were observed on the activity of stearyl-CoA desaturase, but a significant increase was observed for both the transcription rate in liver and the apparent in vivo activity of the fatty acid Δ-6 desaturase and elongase, with increasing dietary cholesterol. This study showed that the possible effects of reduced dietary cholesterol in current aquafeeds can be significant and warrant future investigations.


Full paper

Intake of Farmed Atlantic Salmon Fed Soybean Oil Increases Insulin Resistance and Hepatic Lipid Accumulation in Mice

Abstract

Background

To ensure sustainable aquaculture, fish derived raw materials are replaced by vegetable ingredients. Fatty acid composition and contaminant status of farmed Atlantic salmon (Salmo salar L.) are affected by the use of plant ingredients and a spillover effect on consumers is thus expected. Here we aimed to compare the effects of intake of Atlantic salmon fed fish oil (FO) with intake of Atlantic salmon fed a high proportion of vegetable oils (VOs) on development of insulin resistance and obesity in mice.

Methodology/principal findings

Atlantic salmon were fed diets where FO was partly (80%) replaced with three different VOs; rapeseed oil (RO), olive oil (OO) or soy bean oil (SO). Fillets from Atlantic salmon were subsequently used to prepare Western diets (WD) for a mouse feeding trial. Partial replacement of FO with VOs reduced the levels of polychlorinated

---

Intake of Farmed Atlantic Salmon Fed Soybean Oil Increases Insulin Resistance and Hepatic Lipid Accumulation in Mice

Abstract

Background

To ensure sustainable aquaculture, fish derived raw materials are replaced by vegetable ingredients. Fatty acid composition and contaminant status of farmed Atlantic salmon (Salmo salar L.) are affected by the use of plant ingredients and a spillover effect on consumers is thus expected. Here we aimed to compare the effects of intake of Atlantic salmon fed fish oil (FO) with intake of Atlantic salmon fed a high proportion of vegetable oils (VOs) on development of insulin resistance and obesity in mice.

Methodology/principal findings

Atlantic salmon were fed diets where FO was partly (80%) replaced with three different VOs; rapeseed oil (RO), olive oil (OO) or soy bean oil (SO). Fillets from Atlantic salmon were subsequently used to prepare Western diets (WD) for a mouse feeding trial. Partial replacement of FO with VOs reduced the levels of polychlorinated
biphenyls (PCB) and dichloro-diphenyl-trichloroethanes (DDT) with more than 50% in salmon fillets, in WDs containing the fillets, and in white adipose tissue from mice consuming the WDs. Replacement with VOs, SO in particular, lowered the n−3 polyunsaturated fatty acid (PUFA) content and increased n−6 PUFA levels in the salmon fillets, in the prepared WDs, and in red blood cells collected from mice consuming the WDs. Replacing FO with VO did not influence obesity development in the mice, but replacement of FO with RO improved glucose tolerance. Compared with WD-FO fed mice, feeding mice WD-SO containing lower PCB and DDT levels but high levels of linoleic acid (LA), exaggerated insulin resistance and increased accumulation of fat in the liver.

**Conclusion/Significance**

Replacement of FO with VOs in aqua feed for farmed salmon had markedly different spillover effects on metabolism in mice. Our results suggest that the content of LA in VOs may be a matter of concern that warrants further investigation.


**On-farm feeding and feed management in aquaculture**

**Abstract**

This technical paper provides a comprehensive review of on-farm feeding and feed management practices in aquaculture. It comprises: a) ten case studies on feeding and feed management practices carried out in seven selected countries of Asia and Africa for eight species that belong to four major farmed species of freshwater finfish and shellfish; b) an analysis of the findings of the above ten case studies and a separately published case study for Indian major carps carried out in India; c) ten invited specialist reviews on feed management practices from regional and global perspectives; and d) an overview of the current status of feed management practices. The country-specific case studies were carried out for Nile tilapia (*Oreochromis niloticus*) in China, Thailand, the Philippines, Egypt and Ghana; Indian major carps [rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus cirrhosus*)] in India and Bangladesh, giant river prawns (*Macrobrachium rosenbergii*) in Bangladesh, striped catfish (*Pangasianodon hypophthalmus*) and whiteleg shrimp (*Litopenaeus vannamei*) in Viet Nam and black tiger shrimp (*Penaeus monodon*) in India.

The broad thematic areas that were addressed in these case studies and invited reviews are: i) current feed types (including fertilizers) and their use in semi-intensive and intensive farming systems; ii) on-farm feed production and management; iii) feeding and feed management strategies, feed procurement, transportation and storage; iv) environmental, economic, regulatory and legal frameworks of feeding and feed management practices; and iv) identification of research needs. Based on the information presented in the eleven case studies, ten specialist reviews and from other relevant publications, an
overview paper presents concluding remarks and recommendations on some of the major issues and constraints in optimizing feed production, use and management.

Edited by Mohammad R. Hasan, Michael B. New FAO, Fisheries and Aquaculture Technical Paper 583

Full Paper

THE 5th FIAAP CONFERENCE
~ Ingredients for Success! ~
April 9, 2014. BITEC, Bangkok, Thailand

Effects of diets contaminated with deoxynivalenol and supplemented with mycotoxin deactivator product on levels of Newcastle disease antibody titers in poultry — Dr. Olga Averkieva

Efficacy of anti-mycotoxin additive must be based on target organ protection — Fernando Tamames III

Soybeans in animal feed; more than just crude protein — Dr. Basilisa P. Reas

The use of Lemna based products in aquafeeds — Marcus Kenny

Importance of the gut microbiota for health — Dr. Ei Lin Ooi

Effect of feeding Bacillus-based probiotic on growth performance and health of broilers — Dr. Girish Channarayapatna

The use of protease enzyme in poultry diets: factors to consider for optimum results — Dr. Glenmer Tactacan

Benefits of adding sodium butyrate, a sodium salt of the short chain fatty acid butyric acid, in the feed of broilers and other farm animals — Mathieu Cortyl

Highly Specific Detection of Ruminant DNA in aquafeed — Dr. Gert van Duijn

Pre-registration closes April 1. Register now to confirm your place:

feedconferences.com
## Upcoming Industry Events

### APRIL

- **Apr 8 – 10:** FIAAP/VICTAM/GRAPAS Asia 2014
  - Bangkok, Thailand
  - [Details](#)

- **Apr 8:** Aquafeed Horizons Asia
  - Bangkok, Thailand
  - [Details](#)

- **Apr 9:** FIAAP Asia Conference
  - Bangkok, Thailand
  - [Details](#)

- **Apr 9 – 11:** Offshore Mariculture Conference
  - Naples, Italy
  - [Details](#)

- **April 14 – 17:** AFIA/ NGFA/KSU Short course: Establishing a HACCP Program for the Feed Industry
  - Manhattan, Kansas, USA
  - [Details](#)

### MAY

- **May 13 – 16:** Fisheries Bycatch: Global Issues and Creative Solutions
  - Anchorage, Alaska, USA
  - [Details](#)

### JUNE

- **Jun 5 – 7:** Future Fish Eurasia 2014
  - Izmir, Turkey
  - [Details](#)

- **Jun 7 – 11:** World Aquaculture
  - Adelaide, South Australia
  - [Details](#)

- **Jun 16 – 18:** Aquavision
  - Stavanger, Norway
  - [Details](#)

- **Jun 20 – 21:** International Conference of Aquaculture Indonesia 2014 (ICAi 2014)
  - Bandung, West Java, Indonesia
  - [Details](#)

### JULY

- **Jun 30 – Jul 4:** ASFB and ASL Congress
  - Darwin, Australia
  - [Details](#)

### AUGUST

- **Aug 3 – 7:** 11 International Congress on the Biology of Fish
  - Edinburgh, Scotland
  - [Details](#)

- **Aug 5 – 8:** ExtruAfrica 2014
  - Pilansberg, North West, South Africa
  - [Details](#)

- **Aug 17:** 38th Annual Larval Fish Conference, Quebec City, Quebec, Canada
  - [Details](#)

- **Aug 22 – 24:** 10th International Conference on Recirculating Aquaculture
  - Roanoke, Virginia, USA
  - [Details](#)

### OCTOBER

- **Oct 6 – 9:** GOAL 2014
  - Ho Chi Minh City, Vietnam
  - [Details](#)

- **Oct 14 – 17:** Aquaculture Europe 2014
  - San Sebastian, Spain
  - [Details](#)

- **Oct 14:** 3rd European Percid Fish Culture (EPFC) workshop 2014
  - San Sebastian, Spain
  - [Details](#)

- **Oct 30 – 31:** 5th BioMarine International Business Convention
  - Cascais, Portugal
  - [Details](#)

---

**Visit the Aquafeed Events Page**
International Symposium on Fish Nutrition and Feeding

Cairns Convention Centre, Queensland, Australia
25–30 May 2014

Australia is proud to be hosting the 16th International Symposium on Fish Nutrition and Feeding (ISFNF XVI), the premier international forum for researchers, academics and industry concerned with the nutrition and feeding of aquatic animals.

This biennial event will see several hundred attendees from around the world meet for five days between 25–30 May 2014, in the tropical city of Cairns, adjacent to Australia’s magnificent Great Barrier Reef and the fabulous Daintree Rainforest.

An event not to be missed by researchers, academics and industry—ISFNF XVI will be an opportunity to discuss and debate the current and looming issues faced by the fish nutrition sector and to develop innovative and novel ways to overcome them.

Key themes that will be explored at the upcoming symposium will include:
- Nutritional requirements
- Nutritional physiology
- Practical nutrition
- Raw materials

Key dates*
- Abstract submission opens: late June 2013
- Registration opens: mid August 2013
- Abstract submission deadline: early January 2014
- Earlybird exhibition closes: 31 January 2014
- Earlybird registration closes: 1 March 2014

*dates subject to change

For more information visit the symposium website www.isfnf2014.org or contact the symposium managers:
C/- MCI Australia
P: +61 7 3858 5543
F: +61 7 3858 5499
info@isfnf2014.org

Sponsorship and exhibition prospectus out now!
Download your copy at www.isfnf2014.org and find out how you can get involved today!

We look forward to seeing you in Cairns on Australia’s Great Barrier Reef!