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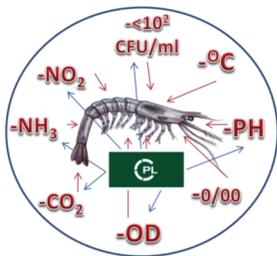
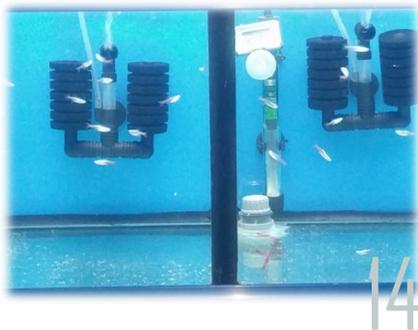


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\* Cover picture: Pabda (Butter catfish) harvest in India.



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# HATCHERY NEWS REVIEW

## SPAIN AND PORTUGAL COOPERATE TO DEVELOP MICROALGAE POTENTIAL



A Spain-Portugal Cooperation Project, ALGARED +, seeks to strengthen the cross-border R & D & i in microalgae biotechnology. It aims to increase the critical mass of research centers, to improve the quality of publications, to promote the mobility of researchers, and

to optimize the resources and infrastructure of each participating organization.

The University of Huelva (UHU) is coordinating this project, with participation from CTAQUA, IFAPA Centro El Toruño,

University of Córdoba (UCO), and CSIC, from the Spanish side. While the University of the Algarve (UAlg), Necton, the Portuguese Institute of the Sea and Atmosphere (IPMA), and Sea4US represent Portugal's participation.

Among the activities planned is bio-

prospecting and the establishment of a transnational collection of new strains of fast-growing microalgae. It will also seek to improve knowledge of key metabolic pathways involved in nutrient assimilation, bioenergy production and synthesis of compounds of interest by microalgae.

CTAQUA will be responsible for the development of new applications for aquaculture based on microalgae, as well as the management, coordination and communication of the results obtained.

The project, which lasts two and a half years, ends on December 31, 2019.

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## INVE AQUACULTURE RELEASES ENHANCED PROBIOTIC FOR SHRIMP FARMING



collaboration with the industry. Feedback was gathered from farmers worldwide to match the new product to their challenges. Rearing trials and AHPND (EMS) challenge tests were conducted in Asia and Latin America, reliably demonstrating the ability of Sanolife PRO-2 to increase growth rate and survival while reducing FCR. The use of the enhanced Sanolife

INVE Aquaculture has released a new and enhanced version of its successful Sanolife feed probiotic for shrimp farming: Sanolife PRO-2.

INVE Aquaculture's innovation team has identified ways to improve the activity and efficiency of the Sanolife strains of *Bacillus subtilis*, *Bacillus licheniformis* and *Bacillus pumilus*. These strains were selected for their ability to inhibit pathogens, be metabolically active in the shrimp gut and in the pond, and improve feed digestibility. The Bacillus strains were deposited in the Belgian LMG Culture Collection, which guarantees the unique composition, quality, performance and consistency of the product.

"The remarkably high Bacillus spore count (20 billion viable spores per g) grants Sanolife PRO-2 the highest number of viable active Bacillus per USD invested," said Olivier Decamp, Product Manager Shrimp Farm, INVE Aquaculture. Bringing its 'Care for Growth' philosophy into practice, INVE Aquaculture has developed this new probiotic in close

PRO-2 probiotic promises to lead to better profitability in shrimp farming, thus supporting INVE Aquaculture's mission to support healthy business growth in aquaculture.

"Considering the renewed Vibrio challenges and white faeces syndrome, this product gives farmers a powerful tool for holistic risk management in their operation," said Olivier Decamp.

### New packaging labels and protocols

The release of the enhanced Sanolife PRO-2 probiotic coincides with the rebranding of INVE Aquaculture's packaging labels, which will be introduced in the market as of September 2017. The product will also be integrated into renewed expert rearing protocols for different culture conditions, from semi-intensive to super-intensive shrimp farming. INVE Aquaculture's local technical support teams will assist their customers to effectively benefit from its performance advantages.

## NEW SKRETTEING CONCEPT BOOSTS MARINE HATCHERY EFFICIENCY AND FLEXIBILITY

Skretting Marine Hatchery Feeds (MHF) has invested considerable R&D into the delivery of ORI-N3, its latest concept in Artemia enrichment that delivers a highly efficient incorporation of essential omega-3 fatty acids into the live feed, as well as far greater flexibility in the essential marine hatchery process.

Developed at MHF's Centre of Excellence in Vervins, France, ORI-N3 is an algae-based liquid. It is supplied in 2kg foil stand-up spout bags and the dosage is simply weighed, mixed with water and then administered to the Artemia tank.

Because ORI-N3 is algal-based there are no superfluous oils, while the risk of oxygen level

challenges are much less likely than with standard enrichments. The Artemia also maintain a good protein base. A direct outcome of these benefits is a greatly reduced mortality rate and much cleaner enrichment.

"With commercial trials of ORI-N3 imminent, our goal is to have the market fully up to speed ahead of the new season, starting in September," says Eamonn O'Brien, Product Manager for Skretting MHF.



## EVONIK LAUNCHES AMINO ACID CALCULATOR FOR TILAPIA FARMING

Evonik has launched a new software tool, AMINOTilapia®, which enables the aquaculture industry to improve efficiency in tilapia farming through optimal feed formulation.

AMINOTilapia® calculates the ideal amino acid recommendations for different growth stages of tilapia considering various production features. The software helps nutritionists to formulate diets that optimally meet the animals' needs and improve feed conversion rate, that is the efficiency with which animals utilize nutrients.

The tool is a step towards modern diets that are formulated to balance amino acids and reduce excess dietary protein, which is usually the most costly component in feed. Balanced diets not only increase efficiency, but also contribute to protecting the environment thanks to a reduced nitrogen excretion.



Tilapia is currently the second most produced fish worldwide, just after carp. The global production of farmed tilapia amounted to more than 5 million tonnes

in 2015. Among different tilapia species, the most popular one is Nile Tilapia, which makes up about 75 percent of farmed tilapia in total.

## NICOVITA INAUGURATES FOURTH EXPERIMENTAL AQUACULTURE CENTER FOR SHRIMP

Nicovita has inaugurated its fourth Experimental Aquaculture Center. It joins the other experimental centers already in operation, such as the Tumbes CEA, which has been operating close to 10 years; the Lima CEA, inaugurated last year, where tests are carried out on growth, performance and digestibility in controlled environments; and the Huancayo CEA for fish.

With this new experimental center specialized in shrimp, Nicovita consolidates its position as the only brand in the Latin American market with an integrated flow process which, together with the

pilot plant and laboratory, enables it to provide a rapid response to the dynamic changes in the market.

On August 24, 2017, Nicovita inaugurated this new Experimental Aquaculture Center (CEA) at its production plant in the city of Trujillo, Peru. The Trujillo CEA represents an additional investment of \$350,000 for Vitapro S.A., with three areas: a module for digestibility, which is made up of three independent sub-modules with water recirculation and temperature control systems, with a capacity for 168 experimental tanks that will allow it to analyze in

vivo digestibility of current inputs as well as new ingredients; a module for culture trials, which is made up of 48 experimental tanks, also with water recirculation and temperature control systems, focused on evaluating performance in the culture of diets that are formulated with ingredients that achieve the best results in digestibility and a room exclusively for attractability tests, which contains 12 experimental tanks that are monitored in real time with video cameras to test the feed attractability and evaluate the effect of different additives or inputs on the animal's acceptance of the feed.



# Industry events

Send your meeting details to:  
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|   |   |
|---|---|
| September   |   |
| 2- 5: Fish Ethology & Welfare (FEW) - Summer Shoal 2017                                       | <a href="http://www.fair-fish.net/FEW2017/">http://www.fair-fish.net/FEW2017/</a>   |
| 4- 7: Larvi 2017 - Fish and Shellfish Larviculture Symposium                                  | <a href="http://www.aquaculture.ugent.be/larvi/">http://www.aquaculture.ugent.be/larvi/</a>   |
| 12- 14: 36th Fish Feed and Nutrition Workshop   | Email: <a href="mailto:adumas@aquatechcenter.com">adumas@aquatechcenter.com</a>   |
| 24– 27: Prospects and challenges for the development of algal biotechnology                   | <a href="http://www.cebitec.uni-bielefeld.de/algal-biotech-2017">http://www.cebitec.uni-bielefeld.de/algal-biotech-2017</a>   |
| 27 - 29: Aquaculture Innovation Summit  | <a href="http://aquaculture-innovation.com/register/pricing/">http://aquaculture-innovation.com/register/pricing/</a>   |
| October   |   |
| 1– 3: 2017 BioMarine Business Convention  | <a href="http://www.biomarine.org/rimouski2017/2017-biomarine-program/">http://www.biomarine.org/rimouski2017/2017-biomarine-program/</a>   |
| 3– 6: GOAL 2017   | <a href="https://www.aquaculturealliance.org/goal/">https://www.aquaculturealliance.org/goal/</a>   |
| 4– 6: XIV International Symposium on Aquaculture Nutrition                                    | <a href="https://sites.google.com/a/uabc.edu.mx/sina17/">https://sites.google.com/a/uabc.edu.mx/sina17/</a>   |
| 17– 20: Aquaculture Europe 2017   | <a href="http://www.aquaeas.eu/meetings/events-diary/71-default/75-conf-trade-show/289-aquaculture-europe-2017">http://www.aquaeas.eu/meetings/events-diary/71-default/75-conf-trade-show/289-aquaculture-europe-2017</a>             |
| 18– 20: International Livestock, Dairy, Meat Processing and Aquaculture Exposition, Indonesia | <a href="http://www.ildex-indonesia.com">http://www.ildex-indonesia.com</a>   |
| 23 - 25: IFFO Annual Conference   | <a href="http://www.iffoevents.com">http://www.iffoevents.com</a>   |
| 25– 27: Aquaculture Vietnam 2017 Expo & Forum   | <a href="http://www.aquafishesexpo.com/vietnam">http://www.aquafishesexpo.com/vietnam</a>   |
| November  |   |
| 2 - 4: AFIA Equipment Manufacturers Conference  | <a href="http://www.afia.org/files/Events%20and%20Meetings/2017/EMC/2017_EMC_Program_f%20low%20res_links%20FINAL.pdf">http://www.afia.org/files/Events%20and%20Meetings/2017/EMC/2017_EMC_Program_f%20low%20res_links%20FINAL.pdf</a> |
| 7 - 10: LACQUA 2017   | <a href="http://www.was.org">http://www.was.org</a>   |
| December  |   |
| 5 - 7: AlgaEurope   | <a href="http://algaeurope.org/conference/">http://algaeurope.org/conference/</a>   |



**AQUAFEED HORIZONS ASIA 2018**  
 March 27, 2018. Bangkok, Thailand.

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# Introduction to broodstock nutrition of cultivable catfish in India

In India, the steady growth in freshwater aquaculture is led by the recent production of catfish, with a share of around 10-15% of the inland sector. Part 1 of this article provides an overview of the effects of nutrition on fecundity, fertilization and embryo development of catfish broodstock and larva quality and the proteins and amino acids requirements of broodstock. In the second part, to be published in the next issue, nutrient requirements will be further discussed along with feeding practices.



Pabda (Butter catfish ) harvest.

By Priya Rawat, Pradyut Biswas, Alok Kumar Jena

Department of Aquaculture, College of Fisheries, Central Agricultural University (I), Tripura-799210, India

Catfish are characterized by a scale less body and a unique taste and delicacy that attract consumers, consequently they fetch a high market price. There are six catfish species being cultivated in India (Table 1). Among six, only two catfish species viz. Pangas and Magur are cultured intensively in the country owing to their higher production rates that are achieved by using various local as well as commercial feeding practices. Catfish production is the fastest growing fish farming segment in India following carp.

Organized catfish aquaculture has not developed as yet in India due to unavailability of fry. The captive seed production techniques for most of the catfish have been developed with a considerable degree of success. The inadequate and inconsistent availability of healthy broodstock is the reason for less survival in catfish hatcheries. Thus availability of an optimal brood stock diet is identified as a key factor for the sexual maturation and reproduction of catfish in captivity.

In view of this, broodstock nutrition is without doubt one of the most poorly understood and researched areas of finfish nutrition. It is fundamental to the progress towards greater control and domestication of aquaculture, as is manifest in the poultry, swine and other livestock sectors. To a considerable extent, the composition of broodstock diet is assumed to have profound effects on gonadal growth, fecundity, reproduction, egg quality and larval quality in several fish species. Moreover, it is also

Table.1: Commercially cultured Catfish species in India

| Sl. No. | Scientific Name         | Common Name                        |
|---------|-------------------------|------------------------------------|
| 1       | Magur                   | <i>Clarias batrachus</i>           |
| 2       | Singhi/stinging catfish | <i>Heteropneustes fossilis</i>     |
| 3       | Butter catfish          | <i>Ompok bimaculatus</i>           |
| 4       | Pangas                  | <i>Pangasius pangasius</i>         |
| 5       | Sutchi catfish          | <i>Pangasianodon hypophthalmus</i> |
| 6       | Sun Catfish             | <i>Horabagrus brachysoma</i>       |

clear that many of the deficiencies and challenges encountered during the early rearing phases of newly hatched finfish larvae are directly related to the feeding regime (including nutrient level and duration) of the broodstock. So, appropriate broodstock diet formulation is essential for the development of healthy catfish broodstock and its breeding plan.

### Importance of broodstock nutrition

During the last decade, increased attention has been paid to the role of different components of broodstock diets. It has been shown that essential fatty acids, vitamins (A, E and C), trace minerals, along with other nutrients in the diet can affect fecundity, egg quality, hatchability and larval quality of broodstock (De Silva and Anderson, 1995), and that the amino acid requirements of broodstock are apparently similar to those for optimal growth (De Silva and Anderson, 1995). The broodstock diet for catfish should be formulated in such a way that it should fulfil the optimum dietary requirements of the

species from commercial to broodstock size in maximal synergy with the environment.

### Effects of nutrition on fecundity of broodstock fish

One of the parameters, fecundity, has been used to assess egg quality of fish, which is affected by the nutritional deficiency in broodstock diets. Fecundity is the total number of eggs produced by each fish expressed in terms of number of egg per body weight. Reduced fecundity, reported in catfish species, could be caused either by the influence of a nutrient imbalance on the brain–pituitary–gonad endocrine system or by the limitation in the accessibility of a biochemical component for egg development. Similarly, reproductive performance has been found to significantly affect the dietary essential fatty acid content. It is found that an elevation of dietary lipid levels from 6–12% in broodstock diets of catfish resulted in an increase in fecundity and hatching. EPA and DHA in broodstock diets of catfish play a vital role by influencing the fecundity of the

broodstock, as selective retention of DHA has also been found during embryogenesis and influences the development of embryo and larvae during starvation. Polyunsaturated fatty acids can also regulate eicosanoid production, particularly prostaglandins, which are involved in several reproductive processes, including the production of steroid hormones and gonadal development such as ovulation.

### Effect of broodstock

Certain dietary nutrients also exert a marked effect on fertilization. Dietary eicosapentaenoic (EPA) and arachidonic acid levels show a correlation with fertilization rates in broodstock. Since sperm fatty acid composition depends upon the essential fatty acid content of broodstock diet in species, it is possible that sperm motility and in turn fertilization would be affected. Several researchers have explained the beneficial effect of EPA and AA on fertilization rates. Both EPA and AA are involved in cell-mediated functions and are precursors of several eicosanoids viz. prostaglandins (PG) which stimulate male sexual behaviour and synchronize male and female spawning, thus directly affecting the success in fertilization. Similarly, ascorbic acid has been shown to play an important role in reproduction and also its role in steroidogenesis and vitellogenesis has been reported. The antioxidant function of vitamins C and E can provide an important protective role for the sperm cells during spermatogenesis and until fertilization by reducing the risk of lipid peroxidation, which is detrimental for sperm motility. The ascorbic acid concentration in the seminal fluid



Pangas (*Pangasius pangasius*) is one of two species raised intensively in India.

reflects the concentration of this vitamin in the broodstock diet and it does not affect semen quality at the beginning of the spawning season. However, a deficiency of ascorbic acid reduces sperm concentration and motility during the latter part of the spawning period.

### Effect of broodstock nutrition on embryo development

Several nutrients are essential for the normal development of the embryo, and their optimum level in broodstock diets improves egg morphology and hatching rates. The percentage of morphologically normal eggs (parameter to determine egg viability) has been found to increase with an increase in the n-3 HUFA levels in broodstock diets and an incorporation of these fatty acids into the eggs. These fatty acids play a major structural role as components of phospholipids in fish biomembranes and are related with the membrane fluidity and correct physiolog-

ical functions for bound membrane enzymes and cell functions.

### Effects of broodstock nutrition on larval quality

Few studies have been able to show the improvement of larval quality through implementation of broodstock nutrition. Supplementation of optimum dietary n-3 HUFA (particularly docosahexaenoic acid) levels in broodstock diets have been reported to improve notably the weight of fish larvae and their resistance to osmotic shock and also improve the percentage of live larvae after yolk reabsorption.

### Nutrient requirements

A nutritionally balanced broodstock diet is necessary for catfish cultured at semi-intensive and intensive levels for promoting their biological and physiolog-

ical processes to accomplish high production. Hence, incorporation of dietary essential nutrients such as protein, lipids, carbohydrates, vitamins and minerals in broodstock diets is essential as these nutrients are metabolized in the body to produce energy for various physiological processes and physical activities. Any dietary scarcity of these nutrients may lead to adverse effects on growth, body composition, health and reproduction of fish. Qualitatively, 40 nutrients have been identified as necessary for the regular metabolic function of catfish.

### Proteins and amino acids

Proteins are the foremost organic material, comprising about 70% of the dry weight of fish tissue, and are required for replacement of worn-out tissue as also several proteinaceous products like intestinal epithelial cells, enzymes and hormones, which are

required for proper body function.

Proteins are also requisite for synthesis of new tissues and hence growth. Catfish, like other animals, actually do not have a true protein requirement, but they require a source of nonspecific nitrogen and essential amino acids. Ingested proteins are hydrolyzed to release amino acids that may be used for synthesis of tissue proteins or, if in excess, used for energy. Use of protein for energy is expensive; thus, catfish feeds should be balanced to assure that adequate levels of nonspecific nitrogen, amino acids, and non-protein energy are supplied in proper proportions.

The requirements for proteins have been studied in catfish for several years. Yet, there is still a contest as to which level of dietary protein provides for cost-effective growth. The dietary protein requirement has a linear relationship with the specific growth rate, and the requirement in fish is affected by nutritional qualities of dietary protein and the level of energy from non-protein sources. Besides, size, water temperature, dissolved oxygen, pH, and feeding rate are also some of the factors that affect protein requirement of fish. Most of the studies on protein requirements of catfish have been based on weight gain and feed efficiency. Data from those studies indicate that the dietary protein requirement for catfish ranges from about 25–50% for semi-intensive and intensive farming. Total protein requirement for optimum growth in catfish have been reported to vary from 25 to 50% of the diet on dry matter basis (Giri et al., 2011).

There exists a high correlation between dietary amino acid requirements and body composition of amino acids. Hence,

Table.2. Amino acid requirements of catfish

| Amino acid    | Requirement (% of dietary protein) |
|---------------|------------------------------------|
| Arginine      | 4.3                                |
| Histidine     | 1.5                                |
| Isoleucine    | 2.6                                |
| Leucine       | 3.5                                |
| Lysine        | 5.1                                |
| Methionine    | 2.3                                |
| Phenylalanine | 5.0                                |
| Threonine     | 2.0                                |
| Tryptophan    | 0.5                                |
| Valine        | 3.0                                |

it is better to formulate fish diets based on amino acid requirements. Nutritionally, amino acids may be classified as either indispensable (essential) or dispensable (nonessential). An indispensable amino acid is one that the animal cannot synthesize or cannot synthesize in quantities sufficient for body needs; thus, they must be supplied in the diet. A dispensable amino acid is one that can be synthesized by the animal in quantities sufficient for maximal growth. Most simple-stomach animals, including catfish, require the same 10 indispensable amino acids (Table 2). There are differences in amino acid requirements among the various species of fish and other animals, but that is expected since the physiological needs for certain amino acids and the relative proportion of structural proteins may vary among species. Dispensable amino acids can be synthesized by catfish, but there are certain advantages if they are provided in the diet. For example, if these amino acids are in the diet, energy is saved in their synthesis, and some dispensable

amino acids can partially spare some indispensable amino acids (cystine can spare about 60% of the methionine, and tyrosine can spare about 50% of the phenylalanine). Practical catfish feeds contain liberal amounts of dispensable amino acids inherent in the proteins of various feedstuffs. In a practical feed, amino acid requirements are best met by feeding a mixture of feedstuffs or by using a mixture of feedstuffs supplemented with amino acids. There has been much debate among fish nutritionists concerning the use of supplemental amino acids by fish. However, data indicate that amino acids are effectively used by catfish when supplemented into a practical feed. In practice, lysine (which is the first limiting amino acid in catfish feeds) is currently the only supplemental amino acid used in commercial catfish diets.

## Lipids

Lipids (fats and oils) are a highly digestible source of concentrated energy, essential fatty acids and phospholipids, and provide a vehicle for absorption of fat-soluble sterols and vitamins. They also play a vital role in the structure of cells and cellular membrane and serve as the precursors for steroid hormones and other compounds, in addition to their function for prostaglandin synthesis. Dietary lipids influence and texture of prepared feeds and also flesh quality of fish. These are highly digestible in fish and are reported to spare protein. Excess dietary lipid suppresses de novo fatty acid synthesis and reduces ability of fish to digest and assimilate, resulting in reduced growth. The type and amount of lipid used in broodstock catfish diets is based on essential fatty acid require-

ments, constraints of feed manufacture, and quality of fish flesh desired. Also, feeding excess lipids produces fatty fish and it will have deleterious effects on flavor, consistency and storage life of finished products.

Catfish cannot synthesize n-3 (linolenic) and n-6 (linoleic) polyunsaturated fatty acids (PUFAs) but fish have a requirement of these two essential fatty acids that are to be provided from exogenous source. Generally, weight gain and feed efficiency are depressed when fish are fed diets containing 15% or more lipids. Catfish have been fed diets containing up to 16% lipid without conclusive evidence as to which level is best for optimum growth. Lipid levels in commercial feeds for catfish rarely exceed 5–6%. About 3–4% of the lipid is inherent in the feed ingredients, with the remaining 1–2%

being sprayed onto the finished pellets. Freshwater catfish, in general, require either dietary 18:2 n-6 (linoleic) or 18:3 n-3 (linolenic) acids or both. Supplementation of n-3 and n-6 PUFA is required for broodstock diet which is done by providing vegetable oil and fish oil of marine source and this greatly influences gonadal maturation, breeding efficiency and spawn recovery of cat fishes.

In the feed of magur (*Clarias batrachus*) the combination of  $\omega$ -3 and  $\omega$ -6 fatty acids elicited the best growth responses of the species (Mukhopadhyay and Mishra, 1998). In common with other vertebrates, catfish cannot synthesize  $\omega$ -3 and  $\omega$ -6 fatty acids *de novo*. Hence one or both-fatty acid must be supplied in the diet, depending upon the EFA requirements. It has been observed that high diet concentration of 18:2  $\omega$ -6 fatty

acid reduced growth and  $\omega$ -3 fatty acid increases the growth rate. NRC (1993) has recommended 12% linolenic acid or 0.5-0.75% Eicosapentanoic acid and Docosahexanoic acid are required for channel catfish. It has been observed that 19% fat in the diet of *Clarias batrachus* fingerlings does not depress the energy digestibility.

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#### More information

Contact Alok Kumar Jena for more information and references.

E: alokkumarjena427@gmail.com

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# The importance of targeted R&D in improving hatchery nutrition

By David E Terrey, Research Technician, Pontus Research Ltd. and Dr. Jack M. James, Principal consultant, Pontus Aqua; Director, Pontus Research Ltd.

With the increasing strain on the marine food industry it is widely accepted that wild fish stocks alone cannot satisfy the increasing demand for seafood (Pauly et al. 2002). The importance placed upon aquaculture as an alternative to commercial capture fisheries demands that the industry continue to expand and develop (Edwards, 2009), increasing efficiency and reducing reliance on dwindling wild stocks. The movement towards fully sustainable production requires further expansion and improvement of aspects of both the hatchery and grow out phases across a broad range of areas such as nutrition, breeding and health.



Within aquaculture in general, one of the most important aspects to consider is the continued development and improvement of feeds, feed ingredients and feed additives and this is certainly the case in the hatchery sector. Improvement here can increase the efficiency of the hatchery itself, optimizing diets and feeding protocols and improving larval and juvenile quality (Hamre et al. 2013). Though considerable progress has been seen in developing our understanding of

larval nutrition, many questions remain unanswered. Hatchery processes for many species, especially marine species, are still dependent on the use of live feed such as rotifers and *Artemia*, despite extensive research into alternatives (Liao et al. 2001; Langdon, 2003; Støttrup & McEnvoy, 2003).

Replacement of live prey with artificial microparticulate diets holds a variety of advantages, but the most important benefit is that their nutritional composi-

tion is uniform and can be tailored to individual species to meet requirements. Current enrichment methods of live feeds are effective; however, they are restricted by the metabolism of the prey, with only the undigested matter being passed on to the fish (Holt, 2011). Secondly the production of live feeds means that a large amount of hatchery space and effort is put into live feed production. Microdiets hold a distinct advantage here, as sufficient feed may be produced prior to a culture season and stored. Though *Artemia* may be stored in a similar way, being sold as cysts which are stable for months, many larval stages of fish are unable to feed on the nauplii after hatching, requiring a diet of rotifers. While rotifers may be raised from diapaused eggs (Gilbert & Shröder, 2004)

the cost of using these eggs, even for a small-scale hatchery would not be feasible. Lastly the use of microdiets is considerably cheaper than the use of live prey as the maintenance and growth of live feeds contributes to a large proportion of running costs in a commercial setting (Person Le Ruyet et al. 1993).

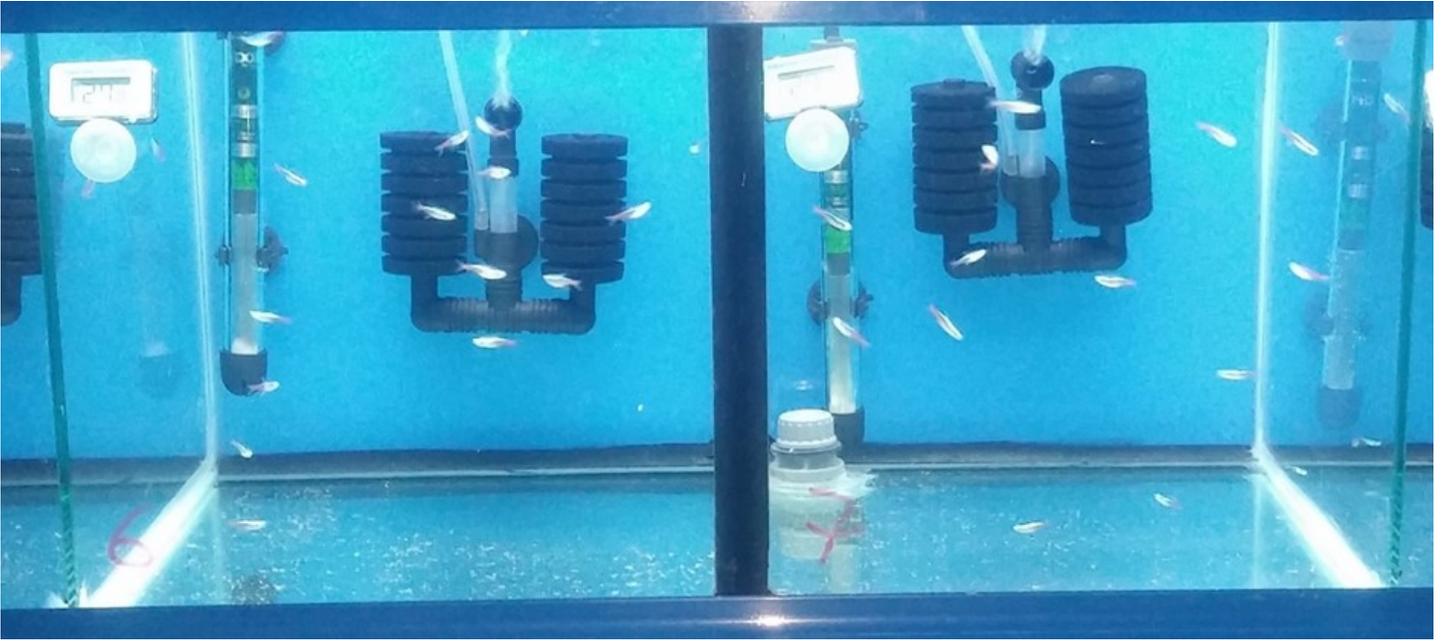
### Microparticle feeds

Despite the clear advantages associated with the use of microparticulate diets the industry has faced challenges in developing artificial microparticles. Several types for microparticle feed have been developed; microbound particles, cross-linked protein walled capsules, lipid

-walled spray beads and liposomes. Each feed type has its own advantages and disadvantages (Table 1) but some problems remain. Small particle sizes result in high rates of diffusion and clumping of feeds can result in substantial losses. Fish larvae are also generally unable to physically break down large particles and as such rely on digestion. The lack of a fully developed gut in larvae means that feed particles must already be in a digestible form and so high solubility of feed is a distinct advantage (Rust et al. 1993; Rust, 1995; Cahu and Zambonino Infante, 2001). However, increasing the solubility of feeds also increases loss of nutrients within only a few minutes of suspension in water (López-Alvarado et al. 1994; Baskerville-Bridges and Kling 2000b). The leaching of

Table 1 Comparison of microparticle types for delivery of nutrients to fish larvae (Holt, 2011)

| Microparticle Type                                  | Advantages  | Disadvantages   |
|---|---|---|
| <b>Micro bound Particles</b>                        | Inexpensive<br>Easy to produce<br>Binders can be nutritionally inert  | Poor retention of LMWS nutrients and possibly water - soluble proteins  |
| <b>Cross-linked protein walled capsules</b>         | Possible to modify capsule wall properties<br>Digestible for some species of fish larvae                          | Expensive<br>Use of organic solvents<br>Poor retention of LMWS nutrients  |
| <b>Lipid-walled capsules and lipid spray beads.</b> | Inexpensive<br>Easy to produce<br>Better retention of LMWS  | Hard - lipid particles not digestible by most species of fish larvae and depends on mechanical breakdown<br>Possible oxidation of unsaturated lipids during preparation and storage |
| <b>Liposomes</b>                                    | Better retention of LMWS nutrients<br>Digestible<br>Phospholipid wall material may contribute to larval nutrition | Expensive<br>Use of organic solvents<br>Preparation involves several steps<br>Possible oxidation of unsaturated lipids during preparation and storage                               |
| <b>LMWS = low-molecular-weight, water soluble.</b>  |   |   |



Hatchery focused research tanks at Pontus Research Ltd, Hirwuan, Wales

these nutrients not only reduces the nutritional benefits of the feed but may also result in hygiene and functionality issues in the culture system. Some feed production methods, like those for cross linked protein walled capsule production, are dependent on the use of organic solvents. Unless these are completely removed during the preparation, they can be toxic to fish larvae and their use can increase the risk of losses. Lipid based feeds such as liposomes also suffer from being susceptible to oxidation, losing unsaturated lipids and labile nutrients (Monoroig et al. 2007b). Even when stored under liquid nitrogen at -80°C substantial losses of micronutrients such as vitamins A, E and C have been recorded (Langdon et al. 2008). Issues like these clearly show the need for the continued development of these products. Until the technology concerning microencapsulation is perfected and a feed particle capable of retaining water-soluble, low molecular weight nutrients and providing them to larvae in a fully

digestible form, larval aquaculture of many species will be reliant on live prey.

### Targeted research

Species specific, targeted R&D is essential to be able to reach the goals set in developing hatchery feeds to improve hatchery efficiency, economics and sustainability. Purpose built, specialist R&D facilities such as those available at Pontus Research Ltd. in Wales, UK are an important asset in moving the industry forward and extensive experimental testing is essential to the development of novel and innovative techniques. Investing in targeted R&D prior to extensive production offers accurate insights into palatability, digestibility and retention, allowing rapid feedback guiding development, production and marketing. The advancement of these techniques is indicative of a movement towards a more sustainable use of resources and microparticulate diets have the potential to create a more

sustainable industry capable of supporting the ever-increasing demand for seafood products.

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#### More information

[www.pontusresearch.com](http://www.pontusresearch.com)

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References available on request

# Importance of feed formulation cost on quality of shrimp larval feeds



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A lot of research has been done on nutrition of shrimp, testing additives and raw materials, and shrimp feeds have changed during the last years. Some of those changes were done to reduce costs and others to increase performance, both in growth and survival.

For larval feeds, the possibilities of research are more limited, because of the short lifespan of the different larval stages. Therefore, the developments are more based on practical applications. If a certain feed composition is working fine, then we can continue with it.

Unlike grower feeds, the actual raw material and formulation cost of larval feeds is not so important in the total production cost or sales price. Even very expensive raw materials like micro-algae, costing 20 Euro or more, are acceptable to include at a couple of percentages.

As a nutritionist, it is a dream opportunity to try to formulate the best possible feed, instead of cutting down on nutrition to make the feed at a competitive price. You can use the best quality ingredients and add everything you want into the formulation to increase the nutritional value.

Of course, the focus is on digestible ingredients, since shrimp larvae have a

rudimentary digestive system.

The highest possible difference in formulation between a high quality feed and average quality feed would probably not be more than 0.5 Euro per kg, which is nothing compared to the total cost of the feed and certainly not in the sales value.

The cost of production, sieving the right sizes, packing etc. will be much higher than the cost of ingredients, as well as the marketing cost.

However, and unfortunately, a lot of other issues are limiting the quality of shrimp larval feeds. Every country seems to have its own rules to allow import of



feeds. Passing import restrictions are the main issue to be successful in supplying hatchery feeds, not the quality.

Even though there is not a single case of a shrimp disease being passed by dry feeds to shrimp, some countries require an analysis of all OIE listed diseases for each batch of feeds produced. It is clear that the cost of these analyses can only be absorbed by a large batch of feeds. Such analysis is surely justified for fresh or frozen diets, but any feed which has undergone a heat treatment is sterilized anyway. Furthermore, a PCR analysis can not make differentiate between a dead or live virus. So even a feed that tested positive for a virus can be perfectly safe.

Then there are other restrictions, like the presence of GMO, terrestrial animal ingredients and so on. Each country seems to have its own focus.

The result is of course that larval feed quality suffers from such restrictions, since the nutritionist can not formulate according to best knowledge but according to the market.

The natural color of a shrimp larval diet is brownish or green (if algae were used). However, most larval diets are black or red, depending on the market. Again, the formulation is adapted to be able to match the preferred color.

It is certain that these restrictions have negatively influenced the potential for improvements, based on research and new available ingredients. It has also prevented new feeds from penetrating the markets, enabling more competition on quality and price, which would have benefited the sector a lot.

For sure, health authorities have a high responsibility regarding preventing

diseases and ensuring human health, but sometimes common sense is completely lost and the restrictions don't make any sense for a feed which is only used for a couple of days at the initial stage of farming.

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# Can feed prevent disease?

## Proactive feeding with Vitalis 2.5 and PL diets for broodstock and shrimp larvae

By Aedrian Ortiz Johnson and Eamonn O'Brien, Skretting Marine Hatchery Feeds

Global warming is affecting the oceans' ecosystems as well as disrupting their physical and chemical parameters. One of those parameters most affected is water temperature, which has risen by 2-3 degrees Celsius above the historical average (The Advocate, Global Aquaculture Alliance). As ocean temperatures rise, so too does the risk of *Vibrio* spp. outbreaks.

Another recognized effect is the increased acidification of seawater, where the pH has decreased from 8.0 to 7.7 in some cases. This represents a significant evolutionary stress for those marine species that depend on the bioavailability of calcium carbonate in seawater.

To counter the negative effects of these environmental changes on shrimp, Skretting has incorporated an immune pack into its Vitalis 2.5 and PL diets, comprising precise combinations of functional ingredients such as organic acids, plant extracts, vitamins, minerals and antioxidants that are proven to work in synergy with the immune systems of shrimp. This helps the animals to better cope with external stressors

External factors that affect the shrimp immune system:

1. Water Quality; Chemical and Physical parameters.
2. Bacterial communities in the water. Influenced by the feed.

Internal Factors that affect the shrimps immune system:

1. Feed Quality.
2. Gut Micro-fauna produced by the feed.

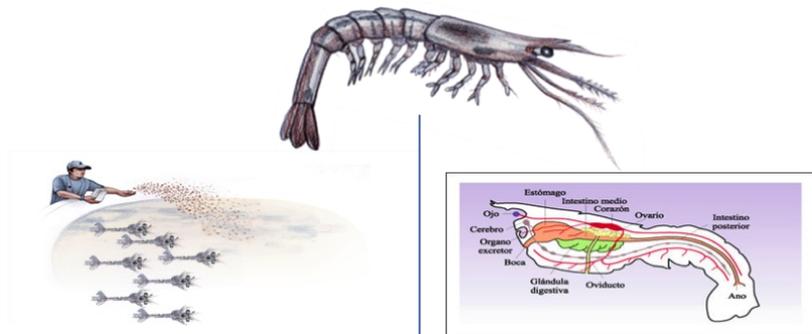


Fig. 1. The shrimp immune system.

and modulates specific genes of the immune system. Group immunity results from the feeds' physical characteristics such as acidity and feces binding, which in synergy maintain better water quality in the culture tanks. The shrimp's immune system is detailed in Figure 1.

Shrimp live in aquatic environments that directly affect their immune systems (Figure 2). Other important factors influencing the immune system include what the shrimp eats and anything that

penetrates its exoskeleton. This is why feed plays such an important role in the immune system, as the feed is not only ingested by the shrimp but also influences the microbial communities in the water through the feed particles that remain present in the water.

Figure 2 illustrates that the feed not only influences the nutrition of the shrimp, it also has a synergistic effect on the water parameters and microbial ecosystem of the culture tanks.

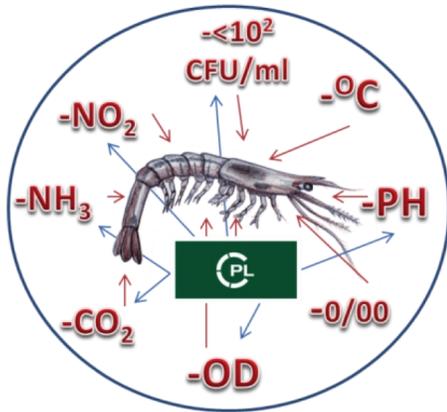


Fig. 2. Effects of feed on the culture tank and shrimp

The immune package that is integrated into the feed looks to protect the exoskeleton, gills, and gut; reinforce immune system, cellular regeneration, and act as an antioxidant; and balance bacteria, virus, and fungi. Results in commercial hatcheries show that survival is higher with shrimp that are fed Skretting diets.

### Skretting diets: Vitalis 2.5 in maturation and PL in larval rearing

In most cases, shrimp fed with Skretting diets had a better survival and better growth – providing a greater likelihood of optimizing success in the hatcheries.

#### Vitalis 2.5

This product is designed to replace a percentage of fresh feeds in the shrimp maturation departments. Vitalis 2.5 can replace up to 80% of fresh diets. Replacing fresh diets that are disease vectors reduces the risk of the broodstock becoming infected and passing disease on to its progeny. This ensures that the first stage of shrimp production is healthy. Vitalis 2.5 is used in quarantine areas before the broodstock enter maturation as well as in the maturation areas.

### Vitalis 2.5 used in quarantine:

**Cases:** Vitalis 2.5 used in the quarantine section of broodstock production

This first case used broodstock that was raised in a low salinity environment, less than 5ppt. Once broodstock are taken to the quarantine area they are acclimated to full strength seawater, which is 35ppt. This presents a stressful situation for the broodstock and in some cases, mortality occurs. The size and specifications of the case are presented in Table 1; results are presented in Table 2.

Broodstock fed with Vitalis 2.5 showed better survival than the group fed with the traditional diet. Development was also greater in the **Vitalis 2.5**-fed animals. This confirmed that the immune package in Vitalis 2.5 provided support for the osmotic balance of the animals fed with the Skretting diet, enabling them to better handle the osmotic stress resulting from the change in salinity.

Further trials are taking place to demonstrate that animals fed with Vitalis 2.5 handle transportation stress much better than those fed with traditional diets. The results will be presented shortly.

#### PL diet

At present, most of the larval rearing departments of the world are being challenged by more pathogenic bacteria being present in ocean water as well as the increasing bacterial resistance to prophylactic treatments.

It is common practice to use a “mix” or “cocktail” of larval diets in the larval departments. We have seen that including a larger percentage of PL diets

Table 1. Size and specifications of case where Vitalis 2.5 was used in the quarantine section of broodstock production.

| SPECIFICATIONS      | UNITS                                  |
|---------------------|--|
| Number of tanks     | 5                                      |
| Water Exchange      | 100%                                   |
| # Broodstock / tank | 400                                    |
| Time in quarantine  | 10 days                                |
| Diet Vitalis 2.5    | 4% of the total biomass Vitalis 2.5    |
| Diet traditional    | 11% total biomass of pellet + 3% squid |

Table 2. Case results.

| DIET        | SURVIVAL |
|-------------|----------|
| Vitalis 2.5 | 85%      |
| Traditional | 45%      |

Table 3. Larvae culture Case 1

| FEEDING PROTOCOL                          | AVERAGE ROOM I | AVERAGE ROOM II | AVERAGE ROOM III | AVERAGE ROOM IV | TOTAL AVERAGE SURVIVAL |
|---|----------------|-----------------|------------------|-----------------|------------------------|
| MIX                                       | %SRA           | %SRA            | %SRA             | %SRA            | %SRA                   |
| 60% Feed 1 + 20% Feed 1 + 20% Flake       | 63.9%          | 84.4%           | 81.2%            | 78.8%           | 77%                    |
| 60% PL Skretting + 20% Feed 2 + 20% Flake | 76.7%          | 72.5%           | 81.2%            | 82.4%           | 78%                    |
| 100% PL Skretting                         |                |                 | 80%              | 84.1%           | 82%                    |

used in such mixes improves the survival rate of shrimp larvae. This is thanks to the immune pack and the good assimilation of the nutrients present in the diet.

### Cases 1, 2 & 3: Larvae culture

In Case 1, we observed different inclusion rates of feeds in the mix fed to larvae. With a greater percentage of PL diet, the survival rate increased, as did the overall health of the post larva produced. The same results were observed in the second case. In Case 3, the results were the same as in raceways, stocking animals that are 300 post larva/gram.

It is important to highlight that in most cases the tanks fed with Skretting diets had their feeding protocols adjusted, as a reduced amount of Skretting feed obtained better results. This is due to the high nutritional profile of the Skretting diets, which make it more bio-available to shrimp larvae as well as making the feeding regime more cost-effective.

In this exercise, there was a 20% more profit than with the traditional diet.

Table 4. Larvae culture Case 2.

| DIET        | SURVIVAL |
|-------------|----------|
| Vitalis 2.5 | 85%      |
| Traditional | 45%      |

Table 5. Larvae culture Case 3.

| FEEDING PROTOCOL                           | NUMBER STOCKED | NUMBER HARVESTED | % SURVIVAL |
|--|----------------|------------------|------------|
| 25% PL Skretting + 25% Feed 1 + 50% Feed 2 | 4,000,000      | 3,432,000        | 85.8%      |
| 50% PL Skretting + 50% Feed 3              | 4,000,000      | 3,560,000        | 89%        |
| 25% Feed 1 + 25% Feed 2 + 50% Feed 3       | 4,000,000      | 2,874,000        | 71.85%     |

Table 6. Cost analysis of larvae culture Case 3.

| FEEDING PROTOCOL                                      | NUMBER STOCKED | NUMBER HARVESTED | POST-LARVA SALE AT \$US2.2/ THOUSAND |
|---|----------------|------------------|--------------------------------------|
| 25% Feed 1 + 25% Feed 2 + 50% Feed 3                  | 4,000,000      | 2,874,000        | \$US 6,322.80                        |
| 50% PL Skretting + 50% Feed 3                         | 4,000,000      | 3,560,000        | \$US 7,832                           |
| Positive difference in favor of Skretting produced PL |                |                  | \$US 1,509.20                        |

**More information:** Aedrian Ortiz Johnson, Technical Support Manager for Skretting Marine Hatchery Feeds: [aedrian.ortiz@skretting.com](mailto:aedrian.ortiz@skretting.com)

Eamonn O'Brien, Product Manager for Skretting Marine Hatchery Feeds  
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# Hatchery feed improves tilapia juveniles' performance

By Delphine Weissman and Gustavo Pizzato, BernAqua

The development of the aquaculture industry is related to several factors, including the production of high quality juveniles. Even in the most common produced species, such as tilapia, mortality rates are often high or variable, and the growth is not always maximized.

Mashed feed or powder feed is commonly used in tilapia juveniles at the initial stage and usually results in satisfactory performances, although those feeds may not meet the nutritional requirements of the species and can deteriorate water quality due to its physical characteristics. Powder feeds have a quick dispersion in the water and a high nutrient leaching which makes its availability for the fish difficult. A new feed production technology can minimize such problems and ensure better performance of the fish in early stages.

The new technology which involves cold micro-extrusion and marumerization ensures high water stability of soluble and insoluble nutrients in the feed while avoiding the use of chemical binders. In addition, cold micro-extrusion avoids

high temperature during the production process and keeps high vitamins levels and digestibility of nutrients.

In order to test the interest of feeding tilapia fingerlings with high quality micro-extruded feed, a trial was conducted in the Centro de Aquicultura da UNESP (CAUNESP) - Brazil, Laboratório de Tilapicultura. During the trial, a commercial premium feed from Bernaqua (MEM®) was compared to a commercial powder feed, traditionally used on tilapia fingerlings in commercial hatcheries in Brazil. The trial lasted 28 days, from day 1 after complete yolk sac absorption (or 3 days after hatching) up to day 28, during the sex reversal period. Two groups were compared; each of them with 6 replicates of 50L tanks containing 180 tilapias.

Fish from the group called MEM were fed with MEM® feed, a cold micro-extruded and marumerized product from Bernaqua Company. The fish from the second group called POWDER were fed with a usual commercial mashed feed.

Feeding protocol and feed size are described in Table 1.

Results showed that growth of tilapia was improved by 80% during the sex reversal period when fish were fed with MEM® (1.18g and 0.65g of weight gain in MEM and POWDER groups respectively). This improvement of growth resulted in higher final live weight at the end of the 28 days trial (1.27g vs. 0.74g in MEM and POWDER groups respectively, as shown on Graph 1). Positive impact of MEM® was also observed on feed conversion ratio (FCR) since it decreased from 1.80 to 1.07 during the trial. This result indicates that the fish fed MEM® would need 40% less feed in comparison to fish fed with POWDER feed, to get the same growth. Survival was similar in both groups and reached 81% in average.

Table 1. Description of the feed used during the trial

| GROUPS | Day 1 to Day 6    | Day 7 to Day 12 | Day 13 to Day 28 |
|--------|-------------------|-----------------|------------------|
| MEM    | MEM 200-300µm     | MEM 300-500µm   | MEM 500-800µm    |
| POWDER | POWDER FEED 300µm |                 |                  |

Better performance of the fish fed MEM® show the interest of microextruded diet to feed tilapia fingerlings that can be explained by greater nutritional value, lower leaching of the feed, better digestibility of the nutrients due the technology of cold-extrusion and marumerization. Indeed, MeM® contains 60% high quality protein whereas mashed feed often contains 55% of total protein, so MEM® might better answer to nutritional needs of the fish. Another advantage of using MEM® is that the size of the feed can be better adjusted according to fish size and can be adapted while fish are growing.

Those results indicate that MEM® is a very promising alternative to powder feed during early stages of tilapia farming, to improve tilapia performances. Feeding MEM® could improve growth rate by 80% and reduce feed conversion ratio by 40%.

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#### More information

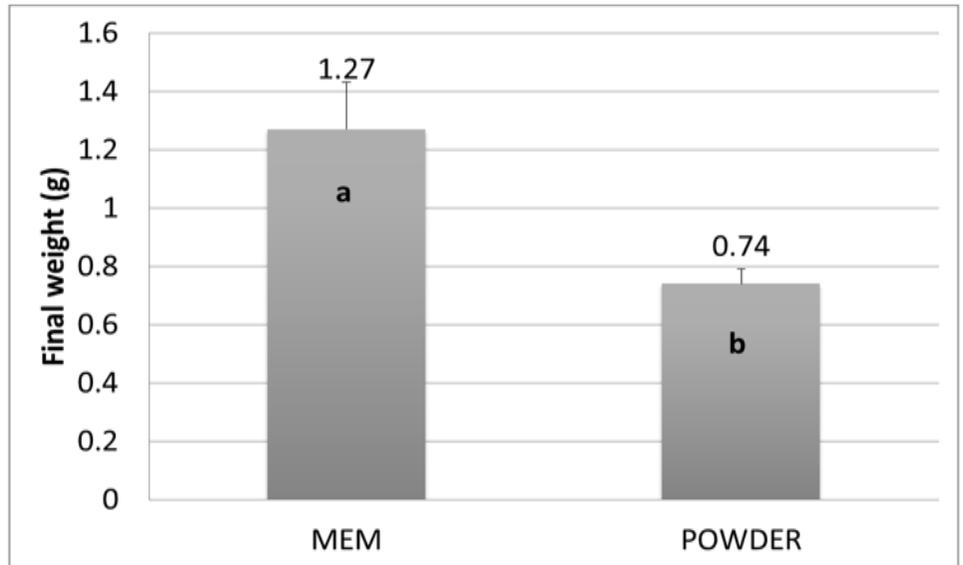


Daniel Arana

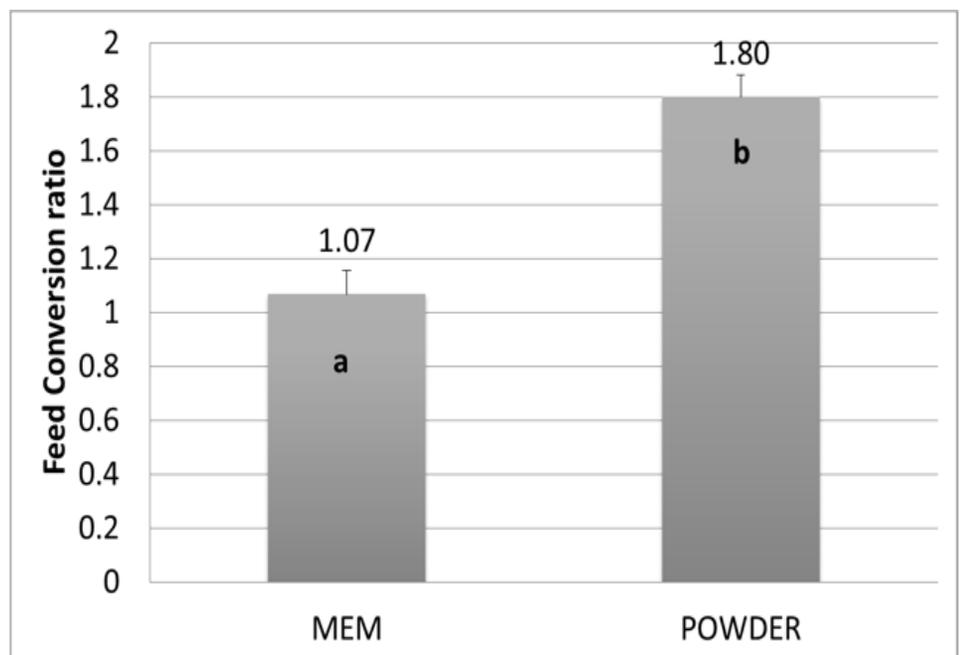
Product Manager, BernAqua

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Graph 1. MEM® improved final live weight of tilapia juveniles by 70% during 28 days feeding trial in comparison to a standard powder feed. Mean±standard deviation of final live weight of tilapia juveniles submitted to two different feeding programs during 28 days. Means with different letters differ from each other by Tukey test at 5% probability level.



Graph 2. MEM® decreased feed conversion ratio (FCR) of tilapia juveniles by 0.73 during 28 feeding trial in comparison to a standard powder feed. Mean±standard deviation of feed conversion rate of tilapia juveniles submitted to two different feeding programs during 28 days. Means with different letters differ from each other by Tukey test at 5% probability level.

# Quality first

Yes, higher quality feed is more expensive pound for pound. But it might prove more profitable nonetheless. In fact, with high quality products, our possibilities are limitless, writes OddGeir Oddsen, CEO of feed producer ProChaete.



## The open cycle

We have come a long way in the shrimp farming industry. Our products are better, more consistent, and we have fewer issues with disease than ever before. In the early days of shrimp farming, farmers harvested broodstock and even PL12 in the wild. It still happens to a degree with black tiger and monodon, but by and large, the industry has closed the biological cycle of the shrimp. Doing so has enabled production of shrimp of a predictable size and quality with no contamination from specimens harvested in the wild. However, a closed cycle also means having to feed both broodstock, nauplii, and shrimp in all PL stages, and to do so one has to find out what a shrimp eats in each stage of its life cycle. Subsequently, the mission is to create a workable feed for each specific stage: Combining

ingredients which shrimp are willing and able to eat in order to get them to next level of maturity. The question remains, however: Should the industry be satisfied with just a workable feed, or should it aim higher?

## Not all PL12 are the same

If a human being wants to become a world-class athlete, her or his chances are better if she or he has eaten nurturing and healthy food since childhood. A shrimp malnourished from birth will never reach its full potential even if it is being fed well in its later stages. But the current pricing scheme in large parts of the industry makes it more profitable for hatcheries and especially nurseries to use low quality feed. When hatchery sell PL12, they sell shrimp based on age, not based on weight. A high quality feed might result in a PL8 being as

big or even bigger than a PL12 eating low quality feed, but this does not bear any financial consequence for the farmer selling his shrimp by age. And so in several parts of the world, opting for feed of a higher quality will not make sense economically. This is unfortunate, because it means that the result of the current pricing scheme ultimately is a lower quality product. But the faults of some of our industry's economic systems do not discourage ProChaete. There will always be a balance between input and output. Instead of looking at feed price, one should look at what the total cost of creating high value-products. At ProChaete, we are committed to making the highest quality feed we possibly can, not only because it's the right thing to do, but because we believe the success of our industry depends on putting quality first.

## The recipe for success

There are a few key requirements one always has to adhere to in the business of making feed of a high quality: Hygiene and biosecurity should be taken for granted, like seatbelts in a car. And, as mentioned earlier, the youngest animals require the very best feed.

We use marine raw materials like micro algae, macro algae, fish and squid and take care to find the optimal combination of nutrients and fatty acids for each of our feeds. All the raw materials have to be finely ground and thoroughly mixed. After all, the animals who are going to eat the finished product are sometimes tiny, tiny beings, so each little piece of feed has to contain the full combination of right nutrients, even for nauplii.

Our very highest quality feed, Optima PRO, has been carefully developed to meet the highest standards in the industry. This is the feed we ourselves use from the start of the lifecycle. With Optima PRO, we have taken things to their extremes, both in terms of ingredient quality end manufacturing process. Instead of buying fishmeal, we buy fish fillets which we then spray-dry.

In addition to using a better source material, we also handle said material more carefully to keep it as nutritious as possible. Optima PRO is agglomerated, meaning that the feed is carefully assembled layer by layer, also in order to preserve as many healthy nutrients as possible, miking the percentage of digestible proteins extremely high. While Optima PRO certainly is more expensive than many other feeds, this is a complete feed for the earliest stages of the cycle (up to PL12), and so the amount used is very low, to the point where price almost becomes irrelevant.

In Excella PRO, we use conventional super prime fishmeal, and we assemble the ingredients by cold extrusion: Grinding, mixing, extruding and crushing the ingredients without applying unnecessary heat. This process helps preserve the important nutrients, and it's a more cost effective way of producing high quality feed, making Excella PRO a cheaper alternative to Optima PRO. Some of our customers prefer to start with Optima PRO and switch to Excella PRO around PL1. Others use Optima PRO all the way to PL12.

In any case, the shrimp have proven to

With Optima PRO, we have taken things to their extremes, both in terms of ingredient quality end manufacturing process. Instead of buying fishmeal, we buy fish fillets which we then spray-dry.



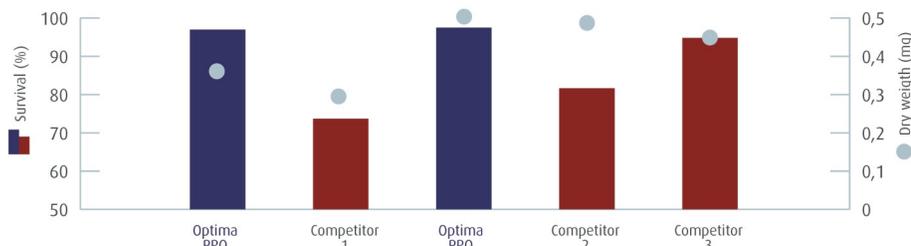
In Excella PRO, we use conventional super prime fishmeal, and we assemble the ingredients by cold extrusion: Grinding, mixing, extruding and crushing the ingredients without applying unnecessary heat.



become bigger, stronger and more stress resistant when being given these high quality feeds. Higher digestible protein values, better production techniques and attention to detail are factors which have enabled ProChaete to deliver feed options for those in the industry who care about high quality output. And in an industry like ours, high quality should be at the forefront.

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### Optima PRO performed the best for both survival and dry weight



Experiment Ecuador on *L. vannamei*  
 Treatment: All feed at 35% + Live feed at 65%  
 Set-up: 50l / tank, 100 zoea/l, 4 replicas / treatment  
 Results at PL-10: survival (%) and dry weight (mg/PL)

### More information

OddGeir Oddsen is CEO of Sea Farms Nutrition. The ProChaete brand was set up in 2013 in order to create innovative feed formulations without the dependency of fish ingredients for marine farming.

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August 25-29 2018

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Directory of  
**MANUFACTURED LARVAL FEEDS**



Photo: Extru-Tech



# MANUFACTURED LARVAL FEEDS

*Links to datasheets available in PDF and digital versions*

| COMPANY    | PRODUCT NAME              | SPECIES | LIFE STAGE               | FORM                     | DESCRIPTION  | DATASHEET               |
|------------|---------------------------|---------|--------------------------|--------------------------|--|-------------------------|
| Aller Aqua | Aller Parvo EX            | Fish    | Larvae<br>Fry<br>Nursery | Crumbles                 | ALLER PARVO EX is a complete starter feed for tilapia, catfish and carp. The feed meets the demands of fry and serves as a good support for fast growth and robust fish.   | <a href="#">WEBSITE</a> |
| Aller Aqua | Aller Futura EX           | Fish    | Larvae<br>Fry<br>Nursery | Crumbles<br>Mini pellets | ALLER FUTURA EX is rich in easily digestible proteins and contains a high amount of natural micronutrients, attractants, minerals and vitamins.<br>The formulation includes raw materials of the highest quality and ingredients especially suited for fry.  | <a href="#">WEBSITE</a> |
| Aller Aqua | Aller Futura MP EX        | Fish    | Larvae<br>Fry<br>Nursery | Micro pellets            | ALLER FUTURA MP EX is an alternative or a supplement to the existing crumbles. The feed is produced by a low-temperature, agglomeration technique, which is gentler to the raw materials than traditional extrusion technology.<br>The physical properties of the ALLER FUTURA MP EX are defined by homogenous, easy-to-handle, dust-free pellets. | <a href="#">WEBSITE</a> |
| Aller Aqua | Aller Performa            | Fish    | Larvae<br>Fry<br>Nursery | Crumbles<br>Mini pellets | ALLER PERFORMA is first of all good value for money and provides excellent growth rates as well as FCR. The product is suitable for a wide variety of conditions and a broad range of species.   | <a href="#">WEBSITE</a> |
| Aller Aqua | Aller Per-formaOrganic EX | Fish    | Larvae<br>Fry<br>Nursery | Mini pellets             | ALLER PERFORMA ORGANIC EX provides good value for money with excellent growth rates and high feed efficiency. The feed intake and wellbeing of juvenile fish is optimized by inclusion of raw materials of the highest quality, with excellent taste characteristics.  | <a href="#">WEBSITE</a> |



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| COMPANY                  | PRODUCT NAME | SPECIES | LIFE STAGE            | FORM                          | DESCRIPTION  | DATASHEET                 |
|--------------------------|--------------|---------|-----------------------|-------------------------------|--|---------------------------|
| BernAqua –<br>InVivo NSA | Caviar       | Fish    | Larvae<br>Juveniles   | Agglomerated<br>Microcapsules | Caviar is an agglomerated product, classified in different sizes to match the different stage of the fish larval development. Each capsule is filled with small peptides and low MW soluble proteins, nucleotides, EFA based phospholipids, a balanced profile of chelated trace minerals, etc.  | <a href="#">DATASHEET</a> |
| BernAqua –<br>InVivo NSA | Nori         | Fish    | Larvae<br>Juveniles   | Agglomerated<br>Microcapsules | Nori is an agglomerated feed high in protein and moderated in fat content, which preserves hepatic conditions and promotes fast growth. The essential fatty acids of the feed are only originating from the protein fraction. Nori is perfectly water stable. It has an excellent buoyancy and water stability.  | <a href="#">DATASHEET</a> |
| BernAqua –<br>InVivo NSA | Royal Caviar | Shrimp  | Larvae<br>Post larvae | Agglomerated<br>Microcapsules | Royal Caviar is formulated and produced to mimic the basic features of live food. Royal Caviar increases profitability and performance of shrimp hatcheries. Royal Caviar is produced following a unique technology, which involves the agglomeration of microcapsules. The key ingredient gives Royal Caviar a better palatability for increased performance. | <a href="#">DATASHEET</a> |
| BernAqua –<br>InVivo NSA | BioSpheres   | Shrimp  | Larvae<br>Post larvae | Agglomerated<br>Microcapsules | The BioSpheres range comprises four different feeds, each one exclusively and independently formulated for the shrimp stage it is targeted to. Each of the feeds is easily identified by their color and physical properties which are following the evolution of the needs of the shrimp throughout its cycle.  | <a href="#">DATASHEET</a> |



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|------------|-------------------------|--------------|--------------------|-------------------|---|---------------------------|
| BioMar     | Larviva Shrimp-ProStart | Shrimp       | From Z1-Z2 onwards | Agglomerated      | Agglomerated, high protein larval feed with the right amino acid balance, for first feeding and replacement of live feed. Available in appropriate size range. Complete nutritional profile. Of constant quality always off-the-shelf available. Includes Bactocell®, a probiotic that is documented to have positive effect on shrimp survival and growth performance. | <a href="#">DATASHEET</a> |
| BioMar     | Larviva Shrimp-PL       | Shrimp       | From PL1 onwards   | Extruded          | An extruded and granulated feed with high digestibility, based on the best raw materials of marine origin. Great importance has been ascribed to palatability, which together with high protein content ensures maximum growth and survival during the early life stages. Contains immune stimulants, and high levels of vitamins and minerals.                         | <a href="#">DATASHEET</a> |
| BioMar     | Larviva ProStart        | Fish         | Larvae             | Agglomerated      | Agglomerated, high protein larval feed with the right amino acid balance, for co-feeding with live feed and for early weaning. Includes Bactocell®, a probiotic that is documented to reduce vertebral deformities in marine larvae as well as in salmonids.  | <a href="#">DATASHEET</a> |
| Bio-Oregon | BioVita Starter         | Salmon Trout | First feeding fry  | Extruded Crumbles | BioVita Starter is a premium fish feed with high levels of fish meal and fish oil. For use in first feeding, it contains an enhanced vitamin pack and pigment to promote healthy fish and natural coloration. Natural palatability enhancers ensure an active first feeding response.   | <a href="#">DATASHEET</a> |



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| COMPANY      | PRODUCT NAME       | SPECIES                       | LIFE STAGE             | FORM              | DESCRIPTION   | DATASHEET                 |
|--------------|--------------------|-------------------------------|------------------------|-------------------|---|---------------------------|
| Bio-Oregon   | BioClark's Starter | Salmon Trout                  | First feeding fry      | Extruded Crumbles | BioClark's Starter combines traditional dietary values with an increased level of alternative ingredients to reduce cost and to promote sustainability. For use in first feeding, it contains an enhanced vitamin pack and pigments to promote healthy fish and natural coloration. Natural palatability enhancers ensure an active first feeding response. | <a href="#">DATASHEET</a> |
| CreveTec     | L100, L200         | Shrimp                        | Larvae                 | Crumbles          | Extremely attractive diet due to inclusion of highly digestible ingredients. All feeds contain micro-algae and hydrolyzed proteins.   | <a href="#">DATASHEET</a> |
| CreveTec     | PL300, PL500       | Shrimp                        | PL                     | Crumbles          | Extremely attractive diet due to inclusion of highly digestible ingredients. All feeds contain micro-algae and hydrolyzed proteins.   | <a href="#">DATASHEET</a> |
| EWOS/Cargill | Micro              | Salmonids                     | Hatchery fry           | Crumbles          | A premium all fishmeal/oil freshwater diet. Results in excellent raceway hygiene and cost effective growth.   | <a href="#">DATASHEET</a> |
| EWOS/Cargill | Pacific            | Salmon, Trout, Coho           | Fry Fingerlings Grower | Extruded Pellets  | High protein and moderate fat diets. Blend of premium fish meals and select alternative proteins.   | <a href="#">DATASHEET</a> |
| EWOS/Cargill | Vita               | Salmon, Trout, Bass, Sturgeon | Fry Fingerlings Grower | Extruded Pellets  | Moderate protein and low fat with fishmeal and highly digestible alternative ingredients.   | <a href="#">DATASHEET</a> |
| EWOS/Cargill | Natura             | Pink & Chum Salmon            | Hatchery Fry           | Crumbles          | High quality fish oil, low fat and higher levels of fish meal substitution with select alternative ingredients.   | <a href="#">DATASHEET</a> |



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|--------------|--------------|----------------|------------------------------------|-------------------------------------|--|---------------------------|
| EWOS/Cargill | Transfer     | Salmonids      | Fry<br>Smolt                       | Extruded<br>Pellet                  | A comprehensive and complete range of hatchery diets from fry to pre-transfer.   | <a href="#">DATASHEET</a> |
| EWOS/Cargill | LiquaLife    | Shrimp         | Larvae                             | Pre-stabilized<br>nutrient<br>beads | LiquaLife® products are liquid feeds for larval and post-larval shrimp produced through a patented technology. Each drop contains pre-stabilized nutrient beads and direct-fed microbials to deliver optimum nutrition for better survival rates and growth. LiquaLife® feeds are designed to complement live feeds, such as algae and Artemia, and completely replace conventional dry feeds. | <a href="#">WEBSITE</a>   |
| EWOS/Cargill | Aquaxcel     | Shrimp<br>Fish | Larvae<br>PL<br>Fry<br>Fingerlings | Micro-extruded                      | Combining superior nutrition and modern micro-extrusion technology, AQUAXCEL® gives young animals all they need to thrive.   | <a href="#">WEBSITE</a>   |



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|---|---------------|---------|------------------------|--------------------|--|-------------------------|
| Gold Coin Biotechnologies SDN BHD   | ENCAP®        | Shrimp  | Larvae                 | Micro-encapsulated | ENCAP® products are microencapsulated with ingredients of the highest quality and digestibility. With our process being carried out at low temperature where minimum heat is involved, there is minimal nutrient loss. When used in hatcheries, the product also display the following advantages: simplicity to use, minimum water pollution, minimal feed wastage, controlled buoyancy, high attractability and faster growth to larvae. | <a href="#">WEBSITE</a> |
| INVE Aquaculture<br>  | O.range       | Fish    | Larvae up to juveniles | Crumbled dry feed  | The ultimate marine fish dry diet range. Consists of 4 diets that perfectly fit the fish's nutritional needs throughout the different hatchery stages. Optimal HUFA and DHA/EPA profiles. Excellent stability and floatability. Formulated using only top quality raw ingredients.   | <a href="#">WEBSITE</a> |
| INVE Aquaculture<br> | NRD           | Fish    | Larvae up to juveniles | Crumbled dry feed  | Top performance dry diet range for marine fish. One diet line for the co-feeding, weaning, post-weaning, nursery and pre-ongrowing stages.   | <a href="#">WEBSITE</a> |
| INVE Aquaculture<br> | EPAC          | Shrimp  | PL                     | Crumbled Pellets   | Post-larval shrimp feed range for low cost applications. NEW formula that includes more marine proteins and lipids, offers better water stability and increased palatability and attractiveness to the PLs. Maintains a clean and healthy rearing environment while allowing a reliable output of robust PLs.  | <a href="#">WEBSITE</a> |
| INVE Aquaculture<br> | FRIPPAK FRESH | Shrimp  | Larvae                 | Micro-encapsulated | A range of advanced larval shrimp feeds. Minimizes Artemia consumption, offering the best balance between live food and formulated diets. Contains high levels of fresh and natural ingredients. Offers higher survival rates and shorter production cycles.   | <a href="#">WEBSITE</a> |



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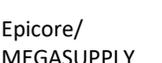
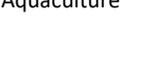
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| COMPANY  | PRODUCT NAME       | SPECIES | LIFE STAGE   | FORM                                     | DESCRIPTION   | DATASHEET                 |
|--|--------------------|---------|--------------|--|---|---------------------------|
|  INVE Aquaculture | FRIPPAK PL FEEDS   | Shrimp  | PL           | Crumbled                                 | High quality diet range for post-larval shrimp. Complementary with our FRIPPAK FRESH range for the larval stages. Minimizes Artemia consumption and produces the best quality PLs. Increases survival rates.  | <a href="#">WEBSITE</a>   |
|  INVE Aquaculture | LANSY-Shrimp       | Shrimp  | Larvae<br>PL | Micro-encapsulated, crumbled, and flaked | A range of high quality dry diets covering all hatchery stages. Replaces at least 40% of the Artemia needs. Manufactured according to the highest sanitary standards, ensuring consistent survival and uniform growth. Excellent buoyancy and water stability.                      | <a href="#">WEBSITE</a>   |
| Lucky Star   | Initial            | Fish    | Larvae       | Micro-encapsulated                       | Nutritionally balanced to satisfy the requirements of marine fish species. Slow sinking to maximize feed availability and avoid feed loss. High levels of digestible protein, utilizable lipids, cholesterol and vitamins. Effective co-feed with rotifer, artemia and micro algae. | <a href="#">DATASHEET</a> |
| Lucky Star   | Larval Plus        | Shrimp  | Larvae       |  | Larval Plus is exclusively engineered to contain complex nutrition to develop healthy and unique reddish pigmentation to benchmark high quality larvae. High in natural anti-oxidants to induce cell development, leading to better growth and survival                             | <a href="#">DATASHEET</a> |
| Lucky Star   | Micro Elite        | Shrimp  | Larvae       | Encapsulated                             | Micro Elite shrimp larval feed is processed by the most advanced encapsulated technology with excellent feed buoyancy in the water column to maximize feed availability. Encapsulated granules extend water stability and minimize nutrition leaching.                              | <a href="#">DATASHEET</a> |
| Lucky Star   | Brine shrimp flake | Shrimp  | Larvae       | Flake                                    | Lucky Star brine shrimp flake is delicately formulated to satisfy the nutritional requirements of quality shrimp larvae.  | <a href="#">DATASHEET</a> |



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|---|-----------------------------|---------|------------------------------------|-----------|--|---------------------------|
| Epicore/<br>MEGASUPPLY<br>         | Epilite Z, M, PL            | Shrimp  | Larvae<br>Post larvae              | Liquid    | EPILITE is a unique range of advance technology liquid larval hatchery feeds that provide superior hatchery nutrition and cause fewer pollution problems than traditional dry feeds.   | <a href="#">DATASHEET</a> |
| Epicore/<br>MEGASUPPLY<br>         | Epifeed LHF 1, 2, 3         | Shrimp  | Larvae<br>Post larvae              | Liquid    | EPIFEED LHF is a unique range of advance technology high concentration liquid larval hatchery feeds that provide superior hatchery nutrition and cause fewer pollution problems than traditional dry feeds.  | <a href="#">DATASHEET</a> |
| Epicore/<br>MEGASUPPLY<br>        | Epibal 300, 500, 700, 1200  | Shrimp  | Post larvae<br>Nursery<br>Raceways | Granular  | EPIBAL is a range of high energy granular hatchery feeds for post larval shrimp.   | <a href="#">DATASHEET</a> |
| Epicore/<br>MEGASUPPLY<br>       | Epifeed Black Artemia Flake | Shrimp  | Larvae<br>Post larvae              | Flake     | EPIFEED ARTEMIA BLACK FLAKE is a high quality flaked hatchery feed for post larval shrimp. Its high-energy nutritional profile enhances animal health and growth.  | <a href="#">DATASHEET</a> |
| Epicore/<br>MEGASUPPLY<br>       | Epifeed Dry 150             | Shrimp  | Larvae<br>Post larvae              | Granular  | EPIFEED DRY 150 is a high energy granular hatchery feeds for Zoea to early post larval shrimp.   | <a href="#">DATASHEET</a> |
| Pacific Trading<br>Aquaculture  | Otohime                     | Fish    | Larvae                             | Granulate | Otohime is made from highly selected raw materials with easily digested protein and high quality lipids to promote the vitality of fish larvae, sizes 75mu to 1400mu. Amazing cleanliness, excellent dispersibility on water surface and ideal sinking speed, this is considered the premium Japanese larval diet around the world.        | <a href="#">DATASHEET</a> |
| Prochaete<br>Innovations Ltd<br> | Excella Pro                 | Shrimp  | Larvae                             | Pellet    | Exella Pro is a high quality shrimp larval and post-larval diet. It provides high survival rates and weight. It has high water stability for maximum feed consumption and minimum nutrient leakage. Excella PRO is naturally buoyant, always available in the water column and perfectly water stable. It also provides high palatability. | <a href="#">DATASHEET</a> |



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|---|--|---------------------|-------------------|--|--|---------------------------|
| Prochaete<br>Innovations Ltd<br> | Optima Pro   | Shrimp              | Larvae            | Pellet                                 | Optima PRO is a truly exceptional shrimp larval and post-larval diet. It provides industry leading survival rates and weight gain. Optima PRO is formulated and produced to mimic the features of live food, it has an outstanding digestibility ensuring a high performance. Optima PRO provides an exceptional palatability. | <a href="#">DATASHEET</a> |
| Reed Mariculture<br>             | Instant Algae®<br>Rotigrow®<br>OneStep All-in-One Feed | Finfish             | Larvae            | Microalgal blend;<br>>14.8% dry weight | RotiGrow® OneStep, with high DHA and optimal EPA and ARA, is a clean, high-yield, microalgal rotifer feed. It is optimized for larvae with high DHA requirements. No secondary enrichment needed. Frozen liquid concentrate, no blending required.   | <a href="#">DATASHEET</a> |
| Reed Mariculture<br>           | Instant Algae®<br>Rotigrow®Plus<br>All-in-One Feed     | Finfish             | Larvae            | Microalgal blend;<br>>14.8% dry weight | RotiGrow® Plus, with moderate DHA and optimal EPA, is a clean, high-yield microalgal rotifer feed. It optimizes enrichment for fish with moderate DHA & ARA requirements. Frozen liquid concentrate, no blending required.   | <a href="#">DATASHEET</a> |
| Reed Mariculture<br>           | Instant Algae®<br>Rotigrow®Nanno<br>All-in One Feed    | Finfish             | Larvae            | Microalgal blend;<br>>14.8% dry weight | RotiGrow® Nanno, with no DHA, is a clean, high-yield, single-species rotifer feed. Our highest yielding feed, it provides the highest biomass conversion rate of our products, with the least organic waste in the tank. Gives a high EPA and ARA enrichment. Frozen liquid concentrate, no blending required.                 | <a href="#">DATASHEET</a> |
| Skretting USA<br>              | Starter Crumble  | Trout and Steelhead | First feeding fry | Extruded Crumbles                      | Starter Crumble is a nutrient rich, crumbled starter feed suitable for Trout, Steelhead and a range of other cold and warm water species. Starter Crumble is produced from a highly digestible, extruded pellet  | <a href="#">DATASHEET</a> |



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|--|--------------|---------------------|-----------------|------------------------------|---|---------------------------|
| Skretting USA<br>   | Classic fry  | Trout and Steelhead | Fry             | Extruded pellets             | Classic Fry, previously called Extruded Steelhead, is a medium-energy, extruded sinking or floating fry diet. Classic Fry is specifically formulated to achieve good growth and healthy fry.  | <a href="#">DATASHEET</a> |
| Skretting USA<br>   | Oncor Fry    | Trout and Steelhead | Fry             | Extruded pellets             | Oncor Fry is Skretting USA's best diet for Trout and Steelhead fry, formulated to ensure good water stability, excellent growth and low FCR. Oncor Fry has a higher level of digestible protein and higher energy content than Classic Fry to ensure that your fish get off to the best possible start.   | <a href="#">DATASHEET</a> |
| Skretting USA<br> | PL           | Shrimp              | PL              | Microparticle                | PL has been designed to provide larval and post larval nutrition for both Pacific white shrimp and black tiger shrimp, from zoea through to nursery transfer. PL, with its unique and innovative composition and thanks to its sophisticated technology process, ensures an optimal availability, freshness and stability of the nutrients.                                       | <a href="#">DATASHEET</a> |
| SPAROS Lda   | WIN Flatplus | Flatfish            | Larvae, Nursery | Micro-encapsulated, Extruded | WIN Flatplus is produced using advanced technologies of microencapsulation and low-shear extrusion. This combination allows creating microparticles with a high digestibility and stability in water. SPAROS larval feeds contain a large fraction of soluble proteins, n-3 HUFA's and marine phospholipids, vital nutrients for an enhanced performance of first-feeding larvae. | <a href="#">DATASHEET</a> |



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| COMPANY                     | PRODUCT NAME        | SPECIES                     | LIFE STAGE     | FORM                                  | DESCRIPTION   | DATASHEET                 |
|-----------------------------|---------------------|-----------------------------|----------------|---------------------------------------|---|---------------------------|
| SPAROS Lda                  | WIN Fast            | Marine fish                 | Larvae         | Cold-extrusion and microencapsulation | A premium weaning microdiet for fast growing marine fish larvae, WIN Fast is produced by cold-extrusion and microencapsulation technologies to preserve nutrients and guarantee high water stability. It is nutritionally balanced for maximum growth and improved stress/disease resistance.   | <a href="#">DATASHEET</a> |
| TomAlgae & INVE Aquaculture | Thalasure® Shrimp   | Shrimp                      | Larvae         | Freeze-dried                          | Thalasure® Shrimp is an innovative diatom product. When fed at large scale to shrimp larvae insignificant changes are required compared to feeding protocols using live diatom suspensions. As storage stable standard quality diatom powder, Thalasure® Shrimp can be rehydrated to large volume cell suspensions, free of marine pathogens, negligible nutrient leaching, and excellent buoyancy.   | <a href="#">DATASHEET</a> |
| TomAlgae & INVE Aquaculture | Thalasure® Mollusca | Oysters and other bivalves  | Larvae, spat   | Freeze-dried                          | Quality Assured, Freeze-Dried Microalgae (diatom) early stage bivalve feed, rich in Omega-3 Fatty Acids with a very favorable EPA:DHA ratio. Used in larval (>160 micron) and spat stages. Main features include storage stability in tropical conditions; simplistic and fast preparation at hatchery site; high digestibility through optimized and uniform cell size; negligible nutrient leaching; comparable or better survival & quality of growth of larval batches. | <a href="#">DATASHEET</a> |
| Tromso Fiskeindustri        | Aglonorse           | Fresh water and marine fish | Larvae and fry | Agglomerated                          | Agglomerated larval diet, formulated with marine ingredients with high digestibility. Designed and formulated to, minimize the use of artemia. An excellent early weaning diet for marine, fresh and ornamental fish larvae.  | <a href="#">DATASHEET</a> |



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|---------|----------------|--------------|------------|----------------|---|---------------------------|
| Zeigler | EZ Artemia     | Shrimp       | Larvae, PL | Micro-capsule  | 100% Artemia Replacement formulated as a complete balanced diet to mimic the color, taste, texture, and nutritional value of Artemia nauplii.               | <a href="#">DATASHEET</a> |
| Zeigler | EZ Larva       | Shrimp       | Larvae, PL | Micro-capsule  | Premium Liquid Larval Diet designed to produce high quality PLs and maintain excellent water quality. Contains algae, pigments, and high HUFA content.      | <a href="#">DATASHEET</a> |
| Zeigler | Larva Z Plus   | Shrimp       | Larvae, PL | Micro-particle | Premium Dry Larval Diet scientifically and commercially proven to produce the highest quality PLs. Contains algae, pigments, and high HUFA content.         | <a href="#">DATASHEET</a> |
| Zeigler | Larva Esencial | Shrimp       | Larvae, PL | Micro-particle | Dry Larval Diet designed to promote fast growth while maintaining water quality in larval rearing systems. Contains pigments and HUFAs from marine sources. | <a href="#">DATASHEET</a> |
| Zeigler | Larva AP-100   | Shrimp, Fish | Larvae, PL | Micro-particle | Dry Larval Diet nutritionally balanced for marine larvae. Contains pigments and HUFA's from marine sources.   | <a href="#">DATASHEET</a> |



SPECIAL ISSUE:

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