Recent Developments in Shrimp Feeds & Feeding

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Abstract

Farmed shrimp currently represent the most valuable segment of the global aquaculture production business at about US $ 22.7 billion in 2013 (farm gate value); total global farmed shrimp production estimated at 4.45 million tonnes (major country producers being China 38.1%, Indonesia 14.0%, Vietnam 12.1%, Thailand 7.4%, Ecuador 6.8%, India 6.5% and Mexico 2.7% in 2013), with production increasing at an average rate of 11.07% per year since 2000 (FAO, 2015). It is estimated that about 84% of total global farm shrimp production was based on the use commercially produced shrimp feeds in 2013, with total global shrimp feed production estimated at about 6.36 million tonnes or about 15.1% of the total estimated global compound aquafeed production in 2013.

With feeds and feeding representing the highest operating cost item of most shrimp farming operations (typically between 35-65 % of total farm operating costs), there is increasing pressure for shrimp feed producers and farmers alike to reduce feed costs per unit of shrimp production. However, despite its relative small size in global terms (97.2 million tonnes), the aquaculture sector is still the largest consumer of fishmeal and fish oil with the sector consuming 68% of the total global fishmeal production in 2012 and 74% of the total global fish oil production in 2012 (Mallison, 2013). The above is perhaps not surprising since fishmeal and fish oil represent ideal feed ingredients for the aquaculture sector by possessing a nutritional profile approximating to the nutritional requirements of most farmed aquatic species, including shrimp; fishmeal not only being an excellent source of dietary protein and essential amino acids but also being a good source of nucleotides, essential fatty acids, phospholipids, minerals, and trace elements (including calcium, phosphorus, magnesium, zinc, manganese, selenium, iodine, molybdenum, and chromium), and fat soluble and water soluble vitamins (including vitamin A, D, E, choline, inositol, and B-vitamins).

It follows from the above discussion therefore that efforts to replace fishmeal with alternative and more sustainable protein-rich feed ingredient sources should focus not only on making good any amino acid

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imbalances through dietary supplementation with aquaculture-grade free amino acids and dipeptides, but must also consider the dietary supplementation of the numerous other essential nutrients usually by fishmeal, including nucleotides, taurine, cholesterol, HUFA, minerals and trace elements. The current paper discusses how the aquaculture feed sector has been able to address the above issues to ensure the continued growth and development of the sector, including through improvements in feed ingredient selection and feed formulation (including the use of amino acids and feed enzymes), improvements in feed manufacturing technology, improvements in on-farm feed storage and management, and improvements in water management and shrimp health. Finally the paper also discusses the need for the improved labeling and reporting of dietary nutrient levels within compound shrimp feeds.

Keywords: shrimp, feeding, management

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Control of Pathogenic Vibrios in Shrimp Aquaculture

Global shrimp production & aquafeed production

Farmed shrimp currently represent the most valuable segment of the global aquaculture production business at about US $ 22.7 billion in 2013 (farm gate value); total global farmed shrimp production estimated at 4.45 million tonnes (major country producers being China 38.1%, Indonesia 14.0%, Vietnam 12.1%, Thailand 7.4%, Ecuador 6.8%, India 6.5% and Mexico 2.7% in 2013), with production increasing at an average rate of 11.07% per year since 2000 (Table 1). It is estimated that about 84% of total global farm shrimp production was based on the use commercially produced shrimp feeds in 2013, with total global shrimp feed production estimated at about 6.36 million tonnes or about 15.1% of the total estimated global compound aquafeed production (Figure 1), and the shrimp industry estimated to have a global economic FCR of about 1.7 in 2013 (Tacon & Metian, 2015).

Table 1. Top fed aquaculture species production in 2013 and estimated compound aquafeed use

Top fed species	Tonnes	APR 20-13	$ billion	Feed Tones
1.Chinese fed carp	13,158,580	5.2%	17.7	11,855,881!
2.Tilapia	4,823,160	11.3%	8.2	7,215,447!
3.Shrimp	4,454,602	11.1%	22.7	6,361,172!
4.Catfishes	4,274,110	10.1%	6.8	4,727,166!
5.Marine fish	2,283,456	8.1%	9.5	3,164,870!
6.Salmon	2,283,093	12.5%	13.8	2,968,021!
7.Misc FW/D fish**	2,206,437	10.5%	4.9	1,390,055!
8.FW crustaceans	1,953,773	4.9%	11.1	1,967,449!
9.Milkfish	1,043,936	8.9%	1.8	1,002,178!
10.Trout	836,569	2.7%	3.6	1,087,540!
11.Eel	231,682	-5.1%	1.3	355,863!
Total	37,549,398	7.3%	101.4	42,095,642!

*!Calculated!from!FAO!(2015); !**!Miscellaneous!freshwater!&!diadromous!fish!

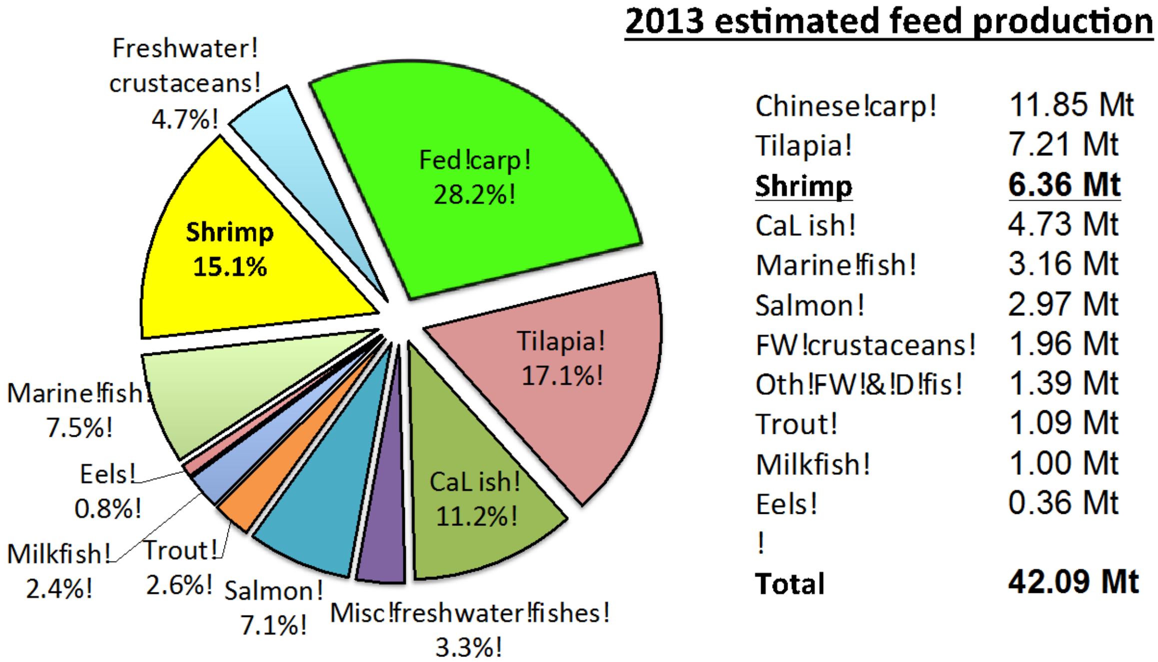

Figure 1. Total estimated industrially compounded aqua feed production in 2013

Shrimp still reliant on fishmeal as a major source of protein & other essential nutrients

According to the latest statistical information from the Marine Ingredients Organization (IFFO) marine shrimp and other crustaceans were the largest consumer of fishmeal in 2013 (estimated at 28% of the total fishmeal consumed by the aquaculture sector in that year (the aquaculture sector consuming 72% of total estimated global fishmeal production in 2013 (Dr Andrew Jackson, Technical Director of IFFO – personal communication). This dependence upon fishmeal is perhaps not surprising since fishmeal has a nutritional profile approximating to the nutritional requirements of most farmed aquatic species, including shrimp; fishmeal not only being an excellent source of dietary protein and essential amino acids but also being a good source of nucleotides, essential fatty acids, phospholipids, minerals, and trace elements (including calcium, phosphorus, magnesium, zinc, manganese, selenium, iodine, molybdenum, and chromium), and fat soluble and water soluble vitamins (including vitamin A, D, E, choline, inositol, and B-

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vitamins (Tacon & Metian, 2015).

It follows from the above therefore that efforts to replace fishmeal with alternative and perhaps more sustainable protein-rich feed ingredient sources should focus not only on making good any amino acid imbalances through dietary supplementation with aquaculture-grade free amino acids and dipeptides, but must also consider the dietary supplementation of the numerous other essential nutrients usually provided by fishmeal, including nucleotides, taurine, cholesterol, HUFA, minerals and trace elements. For a review of the major studies conducted to date concerning the replacement and/or reduction of dietary fishmeal levels within compound shrimp feeds see Tacon et al. (2014).

In general there has been a significant increased use of specific feed additives for shrimp to assist with dietary fishmeal replacement (ie. such as the use of specific limiting amino acids, trace minerals, proteolytic enzymes, fatty acids, attractants, and emulsifiers), to improve shrimp health and wellbeing (ie. such as the use of prebiotics, probiotics, antioxidants, and organic acids) and to reduced the environmental impact impacts arising from feed use (ie. such as the use of phytases, special binders etc.). For a review of the major studies conducted to date see the review of Tacon et al. (2014).

In addition to the above efforts there have also been considerable improvements through the use and blending of different plant and animal feed ingredient sources with complementary dietary essential amino acid (EAA) profiles, the determination of the EAA bioavailability within the feed ingredients used (using a combination of in-vitro and in-vivo digestibility techniques), and the consequent move away from the formulation of shrimp feeds on a total nutrient basis to a digestible or available nutrient basis.

Need for improvements in feed labeling and nutrient declaration

There is an urgent need for the improved labeling of shrimp feeds for the benefit of the farmer and consumer: including the need to move away from the current use of proximate chemical analysis (legal compliance for the declared proximate chemical composition of a feed ingredient or a formulated feed for the purposes of ingredient or feed registration, trade and sales) to the mandatory declaration of specific dietary nutrient levels.

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These specific nutrients could include specific EAA, vitamins, minerals, feed additives), the declaration of the use of genetically modified or banned feed ingredient sources or not (depending upon the country), use of specific feed antioxidants or not, and the possible estimated bioavailability/digestibility of key nutrients present (ie. digestible protein, digestible energy, digestible phosphorus etc).

For example, the current use of proximate chemical analysis (for moisture, crude protein, lipid, crude fiber, ash) to describe the composition of a shrimp feed (or feed ingredient for that matter) is of little or no value to the nutritionist or farmer as it gives no indication of the essential nutrients present or their potential bioavailability or not. Moreover, the current use of proximate analysis, and in particular the calculation of dietary protein level based on total nitrogen levels allows for the possible adulteration of feeds with non-protein nitrogen adulterants such as melamine, ammonium nitrate or urea (Moore et al. 2010).

Need for improved responsible on-farm feed management practices & training

Last, but not least, there is an urgent need for the development of improved responsible on-farm feed management practices, including the use of improved feed transportation and storage techniques, the use of improved record keeping and financial control, and the use of improved on-farm feed and water management, including natural food production and control.

Feeds and feeding represent the largest operating cost item for most semi-intensive and intensive shrimp farming operations, typically between 35 to 65 percent of total farm operating costs. However, in marked contrast to farmed fish species where feeding is usually very rapid and determined visually, shrimp usually feed on the pond bottom (primarily through olfaction) and consequently are not directly visible to the farmer or feeding technician, with pelleted shrimp feeds remaining immersed in water sometimes for several hours before being consumed. In view of the rapid deterioration of shrimp feeds on prolonged immersion in water due to nutrient leaching and the difficulty of shrimp farmers to accurately determine the optimum feeding level and feeding regime for shrimp under semi-intensive and intensive shrimp farming conditions, the success or not of the farming operation is still highly dependent upon the on-farm feed management skills of the farmer. As a direct consequence of the above difficulties, wide variations currently exist between individual shrimp farmers concerning shrimp growth (ie. weight gain) and feed performance (ie. food conversion ratio) with animals being fed the same feed, with the variability being greatest for small-scale shrimp farmers.

It is estimated that over 80% of Asia's aquaculture farms are currently small-scale operations, with poor production practices and disease outbreaks threatening the livelihoods of many smallholder shrimp farmers. Small-scale shrimp farmers currently represents the weakest link within most ASEAN shrimp producing countries, and the sector most vulnerable to the possible use of unsustainable farming practices and potential disease risks. Despite the above, feed companies and national government extension services rarely focus or target smallholder shrimp farmers in terms of training opportunities to improve knowledge and methodologies to improve or enhance their production efficiencies. Moreover, since most ASEAN shrimp is produced for export, it is increasingly subjected to strict controls by importing countries (such as the U.S., Japan and E.U.), including increasing market needs for compliance to BMPs and as well as strict import quality control restrictions regarding food safety issues, including spot checking for antibiotic residues and other unwanted contaminants.

Since the most frequent route of antibiotics use within shrimp feeds is through on-farm feed application by small-scale farmers it is essential that these farmers are made aware of these risks and other important on-farm feed management issues. For the purposes of this paper, on-farm feed management covers all those activities conducted by the farmer and his or her staff concerning the handling, storage and use of shrimp feed on the farm.

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