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Aquaculture feed manufacturing practice in EU Mediterranean countries

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SUMMARY - Aquafeed demand in the Mediterranean EU countries reached around 300,000 mt in 1997, mainly due to the feeding of rainbow trout (65%), and European seabass and gilthead seabream (29%). The technology used in aquafeed production has been moving towards the greater use of extruded feed, representing a large percentage of trout feed and nearly half of marine feed. However *extruded feed* is a very broad term, covering the use of expanders to cooker-extruders. The aquafeed industry in this area is facing the consequences of a change in technology, from conventional steam pellet mills to extruders. This change is reducing the number of feed companies, due to the double effect of a stagnant feed market (as feed efficiency of extruded diets improves) and the need to achieve larger production tonnages so as to remain profitable with this new technology. Moreover, the industry has been further affected by the increasing prices for fishery by-product meals (i.e., fishmeal and fish oil) which, in turn, have increased feed cost significantly.

Key words: Fish feed, aquafeed, Mediterranean aquaculture, aquafeed technology.

RESUME - *"Pratiques pour la fabrication d'aliment aquacole dans les pays méditerranéens de l'Union Européenne". La demande en aliment aquacole dans les pays méditerranéens de l'Union Européenne a atteint environ 300 000 tm en 1997, principalement dû à l'alimentation de la truite arc-en-ciel (65%) et au bar et la dorade (29%). La technologie utilisée pour la production d'aliment aquacole est passée à une utilisation plus étendue d'aliment extrudé, qui représente un grand pourcentage de la nutrition de la truite et environ la moitié de l'aliment marin. Cependant* aliment extrudé *est un terme très vaste, qui couvre depuis l'utilisation des expanseurs jusqu'aux extrudeuses-cuiseurs. L'industrie de l'aliment aquacole dans ce domaine affronte les conséquences d'un changement de technologie, depuis les fabriques conventionnelles de granulés sous vapeur, jusqu'aux extrudeurs. Ce changement est en train de réduire le nombre de compagnies d'aliments composés, en raison du double effet d'un marché des aliments composés stagnant (puisque l'efficacité alimentaire des régimes extrudés s'améliore) et du besoin de réaliser un plus grand tonnage de production afin de rester en bénéfice avec cette nouvelle technologie. De plus, l'industrie a été affectée également par les prix en hausse pour les sous-produits des pêcheries utilisés pour l'aliment aquacole (c'est-à-dire farine de poisson et huile de poisson) qui à leur tour ont augmenté le coût de l'aliment de manière significative.*

Mots-clés : *Aliment poisson, aliment aquacole, aquaculture méditerranéenne, technologie des aliments aquacoles.*

Introduction

Aquaculture is an important activity in the Mediterranean countries. However, although fish production reached 176,000 metric tons (mt) in 1997 (which was 22% higher than output in 1994), this growth has not been transferred to correspondingly larger production tonnage's in the aquafeed sector. Since the arrival of aquafeed extruders, together with other improvements in fish husbandry (i.e., use of oxygen, automatic feeders, fish hybrids, etc.), feed conversion ratio (FCR) has decreased dramatically, resulting in the feed market remaining at the same level as 1994 at about 300,000 mt per year (Fig. 1).

The main markets for Aquafeeds within the region are rainbow trout (62%) followed by the European seabass and the gilthead seabream (these latter two species normally being grouped together) and these accounting for 31% of the total compound aquafeed market. Other species, such as carp, eel and turbot, amounted together for only about 6% of the total aquafeed market. In summary, it can be stated that: (i) trout farming/production has not been growing/increasing in the region and that feed demand has been reduced through improved FCRs (now close to 1:1);

and (ii) although the production of marine finfish species has been growing significantly, the growth in aquafeed demand has been hampered by improved FCRs (although not to the extent of rainbow trout).

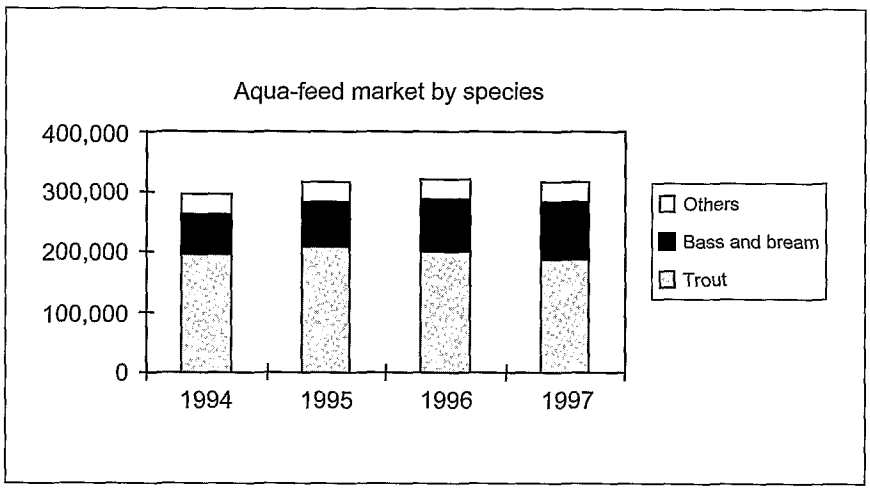

Fig. 1. Aquafeed demand by species in the Mediterranean EU countries, expressed in mt per year for the period 1994 to 1997. This data is based on FEAP (Federation of European Aquaculture Producers) statistics with FCR assumptions by the author.

Although the economic importance of aquaculture development within the region is beyond question, aquaculture production differs widely from country to country. At present the largest aquafeed demand comes from Italy and France; these two countries accounting for 33% and 28% of the total Mediterranean-EU feed market, respectively. However, as mentioned previously, there has been a general decline in the aquafeed market within these countries from 1994 to 1997 due to the FCR improvements obtained by trout farmers. It is estimated that Spain and Greece each accounted for about 19% of the total aquafeed demand, with the aquafeed market growing moderately in Spain and more significantly in Greece (the latter due to marine feeds accounting for a larger share of the total market). Although Portugal currently accounts for only about 1% of the regional feed demand, there are signs that this will increase in the future. Details of aquafeed demand within the region are shown in Fig. 2.

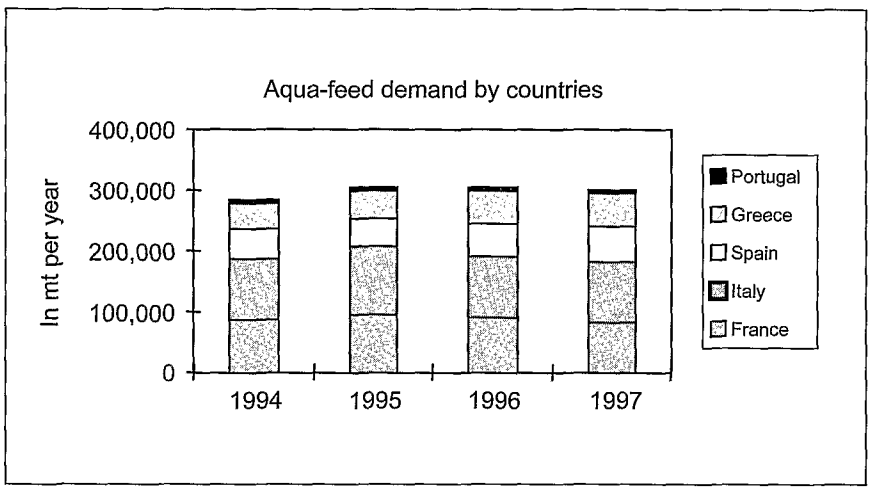

Fig. 2. Aquafeed demand within Mediterranean EU countries for the period 1994 to 1997. Data based on FEAP aquaculture production statistics with FCR assumptions by the author.

Aquafeed types and processing technology

Aquafeed producers generally tend to classify feeds according to their energy level. For example, a classification system which is quite useful to understand the different processing technologies and aquafeed formulations involved is given in Table 1.

Table 1. Classification of fish feeds based upon their energy levels and processing technology†

	High energy (Carnivorous)	Medium energy (Carnivorous)	Low energy (Omnivorous)
Digestible energy (MJ) Protein/fat (%)	15-22 42-47/22-35	14-18 45-47/12-23	13-15 30-40/8-12
Process technology	Cooker extruder	Extruder-expander-pellet mills	Pellet mills
Species	Salmon Eel Trout	Seabass Seabream Turbot	Tilapia Carp Mullet

†Adapted by the author from NRC (1993)

Aquafeed production technology is not unique. It relies on developments made in conventional animal feed processing technology, but with some specific modifications/applications. One important feature of aquafeeds is that the dietary fat sources normally used are oils with a low melting point (i.e., the use of fish oils so as to satisfy the essential fatty requirements of these cold blooded animals). It follows therefore that oil/lipid addition is a key issue during aquafeed manufacture, and as such is a major quality factor both within pelleted and extruded aquafeeds.

For example, using standard pellet mills, the dies and formulations have to be adapted to the use of high dietary fat levels. Similarly, extruders are also standard equipment items and their development and demands for producing aquafeeds are not very different to those of the pet-food industry for producing extruded dog or cat foods. Moreover, for smaller sized fish, pellets are usually crumbled and sieved into four or five different size ranges depending upon the size of the fish to be fed. In some instances more sophisticated methods may be used for the production of larval feeds such as agglomeration, micro-encapsulation, etc., although this market is relatively small.

The key issues in aquafeeds, in terms of processing technology and production, may be summarized as follows:

(i) *Physical quality* of the pellet. As aquafeeds are fed and distributed in water, the pellet/crumble size must be even, dust levels maintained below 1%, the dietary oil component well absorbed, and the density of the pellet adjusted so as to produce a sinking or floating feed as required. Basically the better the physical quality of the pellet the higher the chances that the nutrients contained within the feed will reach the fish and the better the FCR obtained.

(ii) *Multiple formulations and pellet sizes* for relatively small production batches with poor predictability (depending upon the season). For example, a trout generally needs about four crumble sizes and four to five pellet sizes before reaching market size. Moreover, it might also require a finisher diet containing a pigment, adding two to four products more. In addition, considerations concerning the need for different dietary energy levels depending upon the intended rearing conditions also have to be taken into account, which means that the final number of aquafeed products may need to be increased still further.

(iii) *Seasonality* as fish is cold blooded. Since feed demand is related to water temperature and to rainfall (in freshwater), it follows therefore that a feed mill could run only one shift in winter and up to

three shifts during the summer months, resulting in difficulties in feed mill staff recruitment and training, and the poor utilization of assets in winter.

Aquafeed formulations are usually quite different from compound animal feeds and pet foods. For example, because of the low basal energy demands of fish (i.e., cold blooded animals floating within an aquatic environment), farmed fish are generally very efficient transformers of feed into new body flesh. Moreover, since most farmed fish species within the region have carnivorous feeding habits, the formulated aquafeeds usually necessitate the use of high dietary protein and lipid/oil levels.

Fish feed formulations have traditionally been kept simple by using a high standard fishmeal and fish oil content, with the remainder filled with soyabean meal, cereals and some slaughterhouse by-products. However the rocketing prices of fishmeal and fish oils during recent months, together with the relatively high cost of soyabean meal, is dramatically affecting the aquafeed industry. It follows therefore that the fish nutritionist has much less raw materials to choose from (compared with the conventional animal feed nutritionist) due to the need for the use of high dietary protein and fat/lipid levels, coupled with the need to avoid the use of high levels of plant/vegetable fibres and carbohydrates which are poorly digested and transformed by fish.

Fishmeal quality for Mediterranean fish species necessitates the use of meals having a high protein content, and so restricting fishmeals to those produced from whole-fish. Freshness and drying conditions are also important, with higher quality requirements for the aquafeed sector than for the conventional compound animal feed industry. In addition, although fish oil represents a very small percentage of the total world production of animal and plant oils, the price of fish oil is very vulnerable as alternative dietary sources are nutritionally poor (for fish) in comparison. Moreover, the aquafeed industry is currently faced with problems of high cost and availability (the *El Niño* effect) on its raw core materials (i.e., fishmeal and fish oil), which in-turn increases the cost of feed. Meanwhile, fish farmers in the region are currently suffering from a stagnant price development in their production due to increased output (marine fish) or due to changes in distribution channels and over production (trout).

Business environment for aquafeed companies

Fish farming has always been a business with high visibility, and the challenge of farming '*rivers*' and '*oceans*' (and so making fishing obsolete) has attracted many entrepreneurs, and still does. This group of people forms the clientele of an aquafeed company. They are usually very enthusiastic and motivated, but as frontier folks, sometimes carry higher risks than they realize. This "*frontier spirit*" demands a great deal of dedication and a fair amount of knowledge on how to carry out fish farming, including feeding, as well. However, the relatively small size of the fish farming industry compared with the much larger terrestrial animal production sector makes it much more difficult for the farmer to find the information required. It follows therefore that the aquafeed supplier needs to have quite sophisticated consulting skills to cover a wide range of technical issues that may arise on the farm, including issues ranging from pathology, the environment, fish husbandry, feeding strategies and methods, to requirements for new species.

As mentioned previously, the technological changes affecting the aquafeed industry over the past decade have been shaping the sector to resemble more and more that of the compound animal feed industry. If a conventional pellet mill survived in the late 1980s and early 1990s with a production of 10,000 mt per year, the break-even volume with an extruder would be closer to 20,000 mt per year. Consequently, bearing in mind that the aquafeed market has shrunk in some countries, and is virtually the same within the region, one can understand the decline in profitability that many aquafeed companies are experiencing.

Apart from the effect of technological changes in feed manufacture, there are many forces that lead towards to formation of larger aquafeed producing units, such as R&D optimization, increased purchasing power, increased bargaining power with larger customers, greater export possibilities, and increasing demands in quality by customers, etc. The results of this have been quite clear within the region, with the number of aquafeed companies in France decreasing by 30% since 1994, while in Spain and Greece the number of players have been cut by half. Moreover, amongst those companies

still in operation, there are still many companies which are not profitable and are just striving to survive with minimal investments and no product development.

Some companies have developed other product lines to complement aquafeeds, such as pet-foods, or have developed alongside larger compound animal feed mills. However, in our opinion these strategies are only valid in the short term, as it is relatively difficult to combine the production of aquafeeds and pet-foods unless they have dedicated lines (which in turn reduces the synergy). Moreover, as the industries develop the requirements of both segments will become more specific and the customers will grow more sensitive to possible cross-contamination; the net result being that short term solutions cannot hold in the long term. The same would apply to aquafeeds produced within larger conventional animal feed mills, in that the sharing of the same manufacturing equipment would not give sufficient competitive advantage to off-set other disadvantages such as the lack of focus and aquafeed specific skills.

In our opinion aquafeed production is a much more specific business than outsiders may think and as such requires a focused and unique corporate culture/structure; to date the synergism obtained by combining aquafeed production with other business lines/activities have not proved successful. An aquafeed company has to understand the requirements of this industry and be prepared to add value by a competitive combination of product quality, customer assistance, and price. But relying only on the latter would be unwise, since price oriented companies normally do not add value in the long run as they miss the innovation needed, and in the long run therefore loose the market.

Future challenges for the aquafeed industry in the region

There are a number of issues that will shape the aquafeed industry in the future. Although many of these issues have already been mentioned, it is useful to summarize them again as follows:

(i) *Changes in the raw material base*. Aquafeeds have to continue developing away from a fish-based diet to feed fish. This concept is no longer economically possible and has wider implications in the context of sustainable development. A combination of R&D efforts in the areas of raw materials, processing technology and nutrition are needed to take this issue further.

(ii) *Reorganize aquafeed production* into less players/producers, yet powerful enough to undertake the feed developments needed in the next decade (notably on raw material sourcing and applications, feed quality issues and feeding assistance). The larger new factories would have to increase production from the current average of 13-15,000 mt/year to 25-30,000 mt/year, which would mean that only about half of the current 25 aquafeed players/producers would remain. This new size would create competitive advantages in many areas, together with cost savings which could prevent feed prices from increasing.

(iii) *Co-operate closely with fish farmers* so as to better align their interests. Contrary to land based farming, where integration is relatively common, there is a growing trend towards closer cooperation between farmers and aquafeed producers to deal with such issues as fish flesh quality, feed performance guarantees, feeding policies, and joint R&D efforts to breed new species.

(iv) *New feed requirements in general*, notably those related to traceability (i.e., of the ingredients used within aquafeeds), the possibility of the reduced use medicated feeds, the higher degree of compliance with new legislation, package recycling, and the environmental impact of feeds and factories, etc. As all these issues all very important, it follows therefore and the aquafeed manufacturing sector will have to follow the example of the larger animal feed manufacturing sector, who are currently already directly dealing with such issues.

Concluding remarks

The aquafeed and fish farming industry in Europe is still in its infancy, especially when compared to the much larger terrestrial animal production and feed manufacturing sector, and so it follows that its future is still very much in its developmental stage and as yet still to be fully realized. However, preference for fish protein consumption is growing within higher income areas, and in particular within

Asia. Moreover, it is generally accepted that world capture fisheries are at their highest sustainable level and that aquaculture will produce/supply the growing demand of fish.

Although the situation regarding aquafeed production within the Mediterranean EU countries has not been very optimistic during the last four years, it is important to mention that the sector (with a total estimated aquafeed market of 300,000 mt/year) did not exist 20 years ago. Moreover, the change of technology that has changed the shape of the aquafeed industry has been the result of a new level of feed efficiency, and as such is something very positive for the future of the industry.

We are certain that the aquafeed industry will continue its development and will remain instrumental in the support of the growth of the aquaculture sector within the Mediterranean region. However, although the challenges and issues faced by the sector should not be under estimated, these challenges are within the reach from the current technology base. Fish farming, and in particular the culture of marine species, will continue to grow within the region and will become the main fish supplier to the Mediterranean population. In this context the aquafeed industry will significantly contribute to the dreams of those who envisage the advantages of farming fish rather than fishing them.

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