Requirements for some Marine Fish Species with an Emphasis on Organic Ingredients

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Abstract

Actually some fish are well known as for their nutritional requirements such as salmon, red drum, grouper. There is consistent information on protein, lipid and sometimes energy. However, energy is under evaluated for species except salmonids. Some information is lacking on digestible energy for main ingredients, as well as for energy density of fish for some new candidate species such as *Platax orbicularis, Centropomus undecimalis.* Moreover, there is sometimes a discrepancy between the actual data on requirement and what is proposed in commercial feeds. Some company proposed a unique feed for marine specials (all in one) and some farmers select feeds not so in line with the real need of their species; lack of performances or lack of profitability of the production system. In terms of innovation the concept "organic" become more and more in favor for many producers or coordinating bodies to develop fish farming.

Key words. Temperate marine fishes, organic; requirements; warm water fishes; energetics

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Introduction

Background information

A comparative fish growth under the tropics showed a large difference in potential for example a Mahi mahi (C*oryphaena* sea bream) reached 5kg in one year, while a *Siganus* could hardly reach 0.2 kg during the same time. Between those extremes, there was the Jackfish (*Caranx* sp.) (Cuzon *et al*., 1975), groupers, tropical seabass *Lates calcarifer* the European seabass transferred from Europe to the tropics, *Chanos chanos,* just to mention a few examples.

The classification is not so easy; in terms of regimen for example with juveniles cobia in captivity a regimen with 50% plant protein would impair weight gain (Frazer and Davies, 2009) but in general for carnivorous such as trout (Cho and Bureau, 1995), red drum (Mc Googan and Reigh, 1994; 1996, M Googan and Gatlin, 1007), the requirements are well assessed a little less for grouper (Castillo *et al*., 2013) and quite insufficient for tuna (Sanz Brau, 1990) at the difference, herbivorous species are less easy to define, one recall the example of carp with variations such as filter (Silver carp), filter-detritivorous (Big head carp, omnivorous (Indian carp) and common carp.

The known requirements were summarized for trout (Cowey, 1995) and reports on compounded feed mentioned in general 35% protein, 10% lipid with a minimum of 1%(EPA+DHA), 10% carbohydrates and amino acids such as LYS (1.9%), ARG (1.8%) MET (1%) THR (0.8%); vitamins were at 100ppm for stable form of vitamin C, choline at 750 ppm; trace elements 20-25ppm for Zn, and well defined for Mg, Cu, Ca and P. Another species living in warm waters, the red drum, was studied in many aspects of its requirements (Gaylord and Gatlin, 1996; Lohmann and Gatlin, 1993; 93; Craig *et al*., 1992-95; Davis *et al*.1987, 1995; 1996; Moon *et al*., 1991,92;94).

Tools box

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The most detailed nutritional information on marine fish is of course that of salmonids (Corraze *et al*., 2010) and salmon (Cho and Bureau, 1995) *Dicentrarchus labrax* has been studied in the 70's (Metailler *et al*., 1973, 1983) and *mullet Mugil cephalus* (Leray, 1971; Albertini,-Berhaut and Vallet, 1979) and at the same time sea bream (Girin *et al*., 1978), turbot (Person-Le Ruyet, 1983) and sole (Cadena-Roa *et al*. 1980) quickly browsing the main work. More recently, red drum (Gatlin *et al*., 1991-92) has been the subject of many publications on proteins, amino acids, (Brown *et al*., 1988), triglycerids, MCT, EPA, DHA (Davis *et al*., 1995) and even thyroid hormones (These studies have also focused on the digestibility of raw materials (Choubert, 1983). Early 1990's and another fairly comprehensive study was undertaken on the *Lates calcarifer* (Chou *et al*., 1964;.Lee *et al*., 1995) in a research program AADCP S'pore. Lupatsch and Kissil, 2003) has produced an update report on the DP/DE in sea bream *Sparus aurata*.

Today, "new" species are being investigated for example cobia , tuna and breeding attempts on the batfish and also corvina in the tropics, *Centropomidae* .At the same time, studies on *in vitro* digestibility progressed (Lemos *et al*., 2009; Jimenez *et al*., 2012) to classify feedstuffs and provide faster responses than the *in vivo* determination (ADC). That remains however far behind the level of knowledge achieved with Salmonidae in clear water. In addition, feed formulations will be changing with the restriction on fishmeal, the use of vegetable sources (lupine , peas, beans, soybean) and the arrival of macro-algae (*Laminaria*, *Ulva*) and especially microalgae (*Nannochloropsis* , *Chlorella* , *Spirulina*). All this in the new context of organic (BIO), new rearing conditions (" floc " super intensive,..), taking into account the well- being of animals, but the progress on the known species (digestive enzymes , metabolism, special needs,..), however, will probably move faster than in the past. The new candidate species for aquaculture are legion and research does not always follow. it will be missed specific data, manufacturers will be tempted to propose for example feed formulas "for all carnivorous". It is therefore necessary steps, sometimes

short term, as proposed below, or conditioning animals for metabolic studies (tropical *vs*. temperate), metabolic enzymes, additives, nutritional disease, deficiency effects.

The other important aspect of the approach is the situation with raw materials available on the market, their quality, price, and level of contribution to meet the requirements of the species. Obviously, there are several options, one of the major manufacturers that export all continents and smaller units looking for raw materials as close as possible of the site of production. Recently, a minor category at the moment emerged with those who are dedicated to "organic" controlling culture surfaces around the plant itself to guarantee non-GMO feedstuffs (soya, wheat); then the proteins of plant origin can be certified to the required quality. At the level of the EU, these plant proteins are not sufficient for the needs of manufacturers, and the deficit has widened since the feed ban on transformed animal protein (TAP) with the story of the "mad cow" disease. But today, we know that these animal meals could be used in carnivorous fish at least, that got the ability to hydrolyze the prion (protein substance) in the digestive tract (www.agriculture-environnement.fr). In fact, the situation of a lack of protein is obvious and is growing on side of aquaculture with rarefaction of fishmeal or the tendency for certain feed qualities to take only meal from sustainable fisheries (Peru, Chile,..) it will arise therefore in the coming years three changes :(i) lack of marine meals (ii) reintroduction of TAP (iii) use of plant proteins in the formulations. And added to this, little information on new native species recently introduced in farming especially for tropical marine fishes (batfish, cobia). Moreover, the quality of the finished product will take into account the quality of the flesh itself. We know, for example, in a terrestrial monogastric (poultry) that the physiological need for animal protein is there and if they are deprived, the meat is affected (ae, 2013). But, above all, additional pressure to produce fish will come from an urgent need for the next decades to meet food demand from a population in constant progression.

Approaches to a feed appropriate to the species

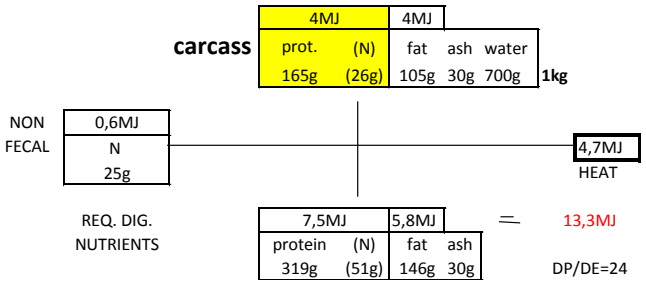
Of course among species, carnivorous ones such as cobia (Lunger *et al*., 2006), red drum (Wisner *et al*., 1991), seabream (Oliva-Teles, 2000), trout (Corraze *et al*., 2010), grouper (Yu *et al*., 2012), barramundi (Lee *et al*., 1005), and "herbivorous" such as siganids (Parazo, 1990), batfish, *Chanos*, or tilapia are under survey to find an adequation between the feed composition and the environmental conditions that generate a wide range of formulations.

-Energetics

Maintenance energy (kJ kg fish per day, HiE) that will vary according to species with for example clear difference between a trout (20% Digestible Energy, DE) and a grouper showing less activity, moving slowly, quite fish in aquaria respired 2.2kJ/MBW*d (Castillo *et al*., 2013). Excretion is not always assessed and in general that is in order of magnitude of 6% de DE enough to get an idea of energy partitioning of the species. Then, with a given feed, a level of retained energy will help for formulation and husbandry, whether the feed is standard (for example 40% RE) or energy dense. Bioenergetics values help formulate a feed (%CP and kJ/g DE) from ingredients known for DE and DP. Some models such as http://nutritiondata.self.com/tools/calories-burned are useful in a scope of application for fish.

For the novel species, an complete analysis of carcass can lead to the concept diet as indicated in an example for trout (table 1) given a whole picture of data needed to elaborate an adequate diet including some metabolic aspects (Cowey, 1992; com.pers.).

Table 1. Carcass analysis (kJ g^{-1}) to conceptual diet



-As described before (Bureau *et al*., 2000) the feed is distributed according to the average weight and the ration will change following a predictive growth rate of the species. An elaboration of a feed is complex now whether one speaks in terms of "organic" or regular feed, but also whether it is dedicated for intensive or semi-intensive, ponds lined or earthen, or cage, or raceways.

-Another approach consists in amino acids profile determination of muscle (or carcass). The analysis of the profile of essential amino acids (EAA) provide information on the quality of the protein and such a correlation with the EAA requirement of a known species will give additional guidance as to limiting factor correction if it carries on like an amino acid such as LYS, MET or THR (Fig. 1).

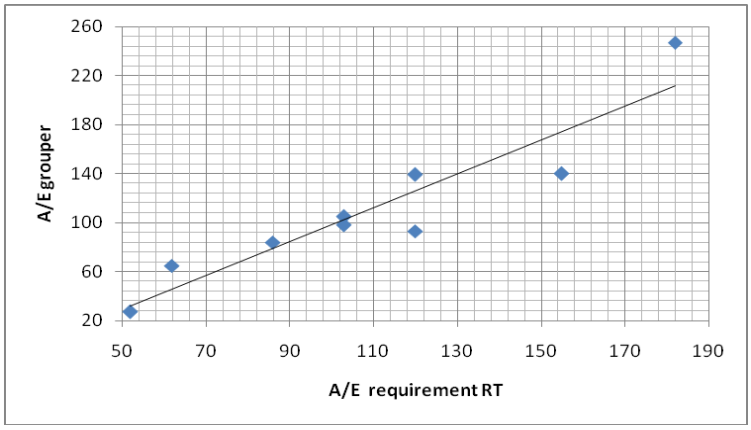


Fig 1. Whole body composition and essential amino acid requirement.

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A/E ratios were calculated as concentration of EAA/sum concentration in EAA*1000. This was an old procedure to enlighten the trend in terms of amino acid profile of an unknown species compared to some well known species such as catfish or trout and find a first idea for the amino acid composition that should be kept from a combination of various ingredients. In the example above (Table 3) a grouper *' E. morio* A/E was probably more in adequation with a trout profile in A/E requirement than any other species in comparison (carp, catfish, salmon, shrimp, carp, tilapia).

There is a number of examples of formulae to make a feed taking into account so many factors such as those given here: 1.conventional in case of trout with a combination in % of herring meal(25), wheat shorts (22) soyabean meal (20) dried whey (10), DDGS (8) fish oil (5) and premix or *Lates calcarifer* with local fishmeal (40), soybean meal (20), wheat (20) and premixes for carnivorous. 2. The version called BIO (organic) for example from Le Gouessant (France) was proposed both for red drum and batfish.

Table 2.example of feed formulation with the concept "organic" for two species *(Platax,* red drum)

	%
FM from sustainable fisheries	24
SBM non GMO	18
Corn gluten meal	15
organic wheat shorts & soy concentrate	24
canola meal	9
premix (oil, vit. min. additives)	10

Those two species are actually fed with this kind of "organic feed" to guarantee to the consumer a quality of the product, with an emphasis of feedstuffs carefully selected and in

final an extruded feed that do not content residual pesticides or heavy metals at least below the authorized levels.

Energy dense feeds were allocated to trout and salmon two decades ago; and the main concern today is for plant-based and microalgae microalgae-based feeds. There is a significant effort to propose feeds for herbivorous such as siganidae with profile such as

FM (5), SBM (10), cereals (30), copra (5), alfalfa (25), yeast (15), molasses, premix and *Medicago*(a plant in use do feed juveniles of Siganidae).

All these situations with natural productivity in floating cages;(*Platax)*. In ponds with liner, in pens, in «floc»; could lead to adapt the composition of the feed; the reference to requirements in clear water is each time, obviously a way of verification and rectification if necessary.

Conclusion

Food for marine fish will evolve in the next decade and searches are undertaken since several years in some directions (microalgae, macroalgae, concentrates, isolates). Two large groups will bring different needs (herbivores and carnivores) and is sure that in the future context, the herbivores will find favor in many countries of the tropics in particular. *Tilapia* in this regard has been in rapid development, however, far from solving a world hunger as could be expected in the 70's. However , the level of theoretical and practical knowledge today provides opportunities breeding cages, ponds , water at different salinities , semi-intensive , intensive, super- intensive (monosex red tilapia) and feeding by compounded feeds followed with roughly formulas that matched the requirements and these requirements could change from one farming system to another and paradoxically the super -intensive farming possible to reduce tau protein due to a phenomenon " external rumen " to the environment as well as In the microbial treatment substantial contribution

compensating a relatively high " greening " of the food. Unfortunately, not all species are not as easy to breed and among marine fish intensification culture can create problems especially diseases and parasites saddled some farms. The expression of the growth potential is not always reached by species but some of them like *Lates calcarifer* surprised Nordic nutritionists with rapid growth rate that the temperature of the sea water is 27°C. Aside salmonids, can be seen today *Lates* and grouper farms in Indonesia with over 4000mt instantaneous biomass in floating cages and fish receive an extruded feed from Europe. A far cry from the days of "trash fish" although it is still up in this or that operation of the SEA or even whole sardines for tuna farming in the Mediterranean or in Baja California or Australia for example. And commercial feeds have taken over with good recognized grow-out performance as well as breeding in captivity (bass, bream, batfish), which indicates a degree of control and the need for maintaining the animals in optimal conditions (photoperiod, T°C, salinity, DO). All these developments have production of farmed fish in temperate and especially more and more tropical areas). Progress remains to be made with the additional pressure taking account of recent welfare of fish and the health of consumers.

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