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Recent advances in Mediterranean aquaculture finfish species diversification

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Method for selection of new marine fish species: The case of pollack (*Pollachius pollachius*)

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SUMMARY – A method allowing an appraisal of the potential interest for aquaculture of new marine fish species is proposed in this paper. It includes four successive steps: a survey of the main trends in fish market, a selection of a fish species regarding biological characteristics available in the literature, some preliminary zootechnical experiments completing available data and a technico-economical analysis. The method is validated by a determination attempt of the capacity of pollack, an Atlantic fish species, for aquaculture development in France. Between 1987 and 1997, the consumption of fresh fish by French household remains constant. During the same period, the market share of fresh cuts or prepacked fish has largely increased at the expense of whole fresh fish. The development of this standard market share has been sustained by the soaring role of supermarkets in the distribution chain. Because aquaculture has focussed on the whole fish market, its production is not adapted to this new market segment. Intrinsic characteristics of pollack-a good adaptation to captivity, a high growth capacity and a good quality flesh-sustain its candidature for aquaculture. A technico-economical analysis showed that pollack was well adapted to the transformation market segment. However, further investigations are needed to improve survival during the hatchery phase, allowing to precise the specific requirements of pollack for aquaculture.

Key words: Selection method, new fish species, French fish market, pollack, *Pollachius pollachius*.

RESUME *– "Méthode de sélection de nouvelles espèces de poissons de mer : Le cas du lieu jaune (*Pollachius pollachius*)". Ce travail propose une méthode de sélection permettant de déterminer l'intérêt potentiel de nouvelles espèces de poissons pour l'aquaculture. La démarche est divisée en quatre étapes successives : une étude des principales tendances du marché du poisson, une sélection d'une espèce grâce aux données biologiques disponibles dans la littérature, quelques essais zootechniques préliminaires permettant de compléter les données disponibles ainsi qu'une étude technico-économique. Cette méthode est validée par l'évaluation de l'intérêt aquacole du lieu jaune, en France. Entre 1987 et 1997 et sur le marché français, la consommation en poissons frais des ménages demeure constante. Durant cette période, le segment de marché du poisson frais découpé ou emballé s'est largement accru, aux dépens de la consommation de poissons frais entiers. Ce développement du marché de poisson standard a été soutenu par le rôle croissant des supermarchés dans la chaîne de distribution. En raison de sa concentration sur le créneau du poisson frais entier, l'aquaculture n'est pas adaptée à ce nouveau marché. Les qualités intrinsèques du lieu jaune-une bonne adaptation à la captivité, une bonne capacité de croissance et une chair de bonne qualité-soutiennent la candidature de ce poisson à l'aquaculture. Une étude technico-économique montre que le lieu jaune est bien adapté au marché du poisson standard. Des recherches supplémentaires sont nécessaires afin d'améliorer la survie durant la phase d'écloserie, permettant de préciser les besoins spécifiques du lieu jaune.*

Mots-clés : *Méthode de sélection, nouvelles espèces de poissons, marché français du poisson, lieu jaune,* Pollachius pollachius*.*

Introduction

With a close to 30 years experience, the diversification of marine finfish aquaculture has acquired its own history. First attempts at selecting new fish species have been carried out taking into account objective criteria such as selling price or growth potential but also local or even subjective parameters such as the possibility to fish juveniles or breeders in the wild, the existence of a local limited market of interest, up to... an emotional "fish-appeal" for a single attractive species, considering it as a pet! Reviewing the status of aquaculture, New (1991) selected from FAO statistics, 9 fish species as

promising candidate for fish farming. Eight years after, the same author described the changes observed in their production: between 1987 and 1996, expansion ratio was ranging from –1.5% up to 210.3%, depending on species. In order to avoid the case of common sole (*Solea vulgaris*) which expansion ratio during this period was –1.5% (total production in 1996: only 29 mt) and to bet on a candidate which looks promising, selection programs must consider complementary aspects including main trends in fish market and biological features. This global approach will help to rule out the haunting question, "is this new fish species really adapted to my own constraints?"

This paper aims at settling a selection method for new marine fish species including these different scopes. The method is validated by a determination attempt of the capacity of pollack, an Atlantic fish species, for aquaculture development in France.

What are the main trends of the French fish market?

From 1987 to 1998, the household total fish consumption in France as estimated from the SECODIP panel (representing close to 70% of the total fish consumption in France), is around 190,000 mt. The variation of this consumption is very low, the coefficient of variation between these different years being only 4.5%. In contrast, trout and salmon consumption has grown steadily, at the expense of other species, ranging from 3% of the household fish consumption in 1986 up to 20% in 1997. On the French market, salmon is now the first most common fresh fish for household consumption (*Salmo salar*, 14.4%), the second being cod (*Gadus morhua*, 12.2%). This success can be explained by different factors such as the excellent image of salmon, its ability to be diversified in size (from 1 to 7 kg) and in presentation (whole, filleted, fresh, smoked, frozen or ready-cooked), and the supply regularity. This large increase of salmon market share illustrates the elasticity of the French fish market reported by Kinnucan *et al*. (1997), suggesting substitutability between different species. In 1997, the consumption of fresh fish represents 62% of the total household consumption of fish in France. Between 1987 and 1997, this consumption remains constant. However, the part of cuts of fish has largely increased (Table 1).

Table 1. Changes in the household French market of fresh fish between 1987 and 1997 (source: SECODIP, 1997)

Type of product	Volume in 1987 (mt)	Volume in 1997 (mt)	Expansion ratio (%)	Value 1987 (MEuros)	Value 1997 (MEuros)	Expansion ratio (%)
Total fresh	168,001	145,748	–13	1112	1207	9
Whole fresh fish	99,635	61,599	–38	572	426	–25
Cuts of fresh fish	68,366	84,149	23	540	781	45

Such changes in the fresh fish market can be linked with the partition of the consumers in two populations described by Paquotte (1998): first, a connoisseur population, looking for specific species and being demanding consumers and second, a standard consumer population, just looking for fish flesh. The connoisseur buys whole high quality fish. However, this outlet is receding with the new generations of consumers. Standard consumer looks for fish flesh at low cost and ready cooked. The identification of the species and its origin (wild or farm raised fish) is less important for this last market share. 36% of the consumers of fresh fish only buy cuts or prepacked fish. On the other hand, 8% of the consumers of fresh fish only buy whole fish. Furthermore, the same consumer may shift from one pattern to another one: for instance, the same person will buy standard quality fillets for everyday meals and expensive fish for a special occasion during week-end. This soaring role of the standard fish market can be explained by the changes in lifestyle and especially by the development of female working, the increasing part of leisure and out of home catering.

Analysis of SECODIP profiles (Table 2) shows that the consumers of cuts or prepacked fresh fish are well distributed among socio-demographic classes. However, such consumers tend to be young and live in large urban centres. Development of this market segment is curbed in household presenting low income.

Table 2. Socio-demographic profile of fresh fish household consumers (source: SECODIP, 1997)

		Whole fish	Cuts of fish	Prepacked fish
Age	<35	15.3	21.3	22.2
	35-49	24.4	24.4	28.5
	50-64	31.4	26.4	24.4
	>65	28.9	27.9	24.9
Income	High	25.3	27.3	29.2
	Upper intermediate	25.5	27.3	27.9
	Lower intermediate	25.7	25.8	23.5
	Modest	23.5	19.6	19.4
People in family	1	18.6	21.8	24.9
	2	28.7	26.8	23.3
	3	26.1	25.8	23.9
	4 and >4	26.6	25.6	27.9
Agglomeration (inhabitants)	<2,000	24.2	24.4	19.9
	2,000 – 49,999	25.1	25.4	21.9
	>50,000	26.1	25.8	30.1
	Paris	24.6	24.4	28.1

Main reasons explaining the purchase of prepacked fish are its practical aspect, the saving of time during shopping and cooking, and the high hygiene because of the absence of contact during manipulations. Compared to whole fresh fish, most consumers did not perceive any disadvantage. However, buyers required a larger panel of species and quote a lower freshness and an expensive price (FIOM, 1986). The market of cuts and prepacked fish may differ between regions of France: in 1997, it represents 10% of the sales in Paris and in the South-east, up to 15% in the Centre-east but only 5% in the West (FIOM, 1997). In France, supermarkets are the first distribution channel for fresh fish, representing in 1997, 66% in volume and 62% in value (FIOM, 1997). This is especially the case for cuts and prepacked fish (Fig. 1) for which traditional markets constitute a minor outlet (Girard *et al.*, 1998; Paquotte, 1998).

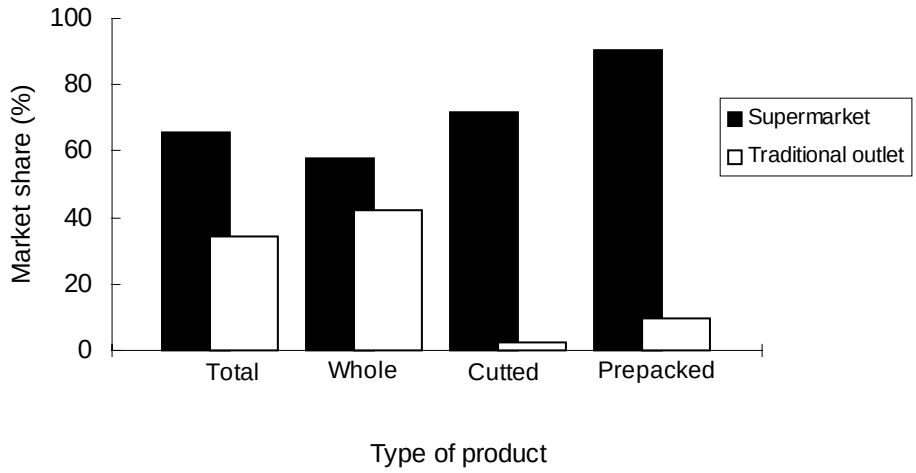

Fig. 1. Distribution of fresh fish consumption in relation with the type of distribution channel (source: SECODIP, 1997).

Because of its high brand image and its moderate selling price, the presence of salmon on the fish stalls has contributed to attract consumers to supermarket (Montfort, 1996). On the French market, the mean price differs between these different presentations of fresh fish (Table 3).

Table 3. Mean price of the different presentations of fresh fish on the French market (source: SECODIP, 1997)

	Total fresh fish	Whole fish	Cuts of fish	Prepacked fish
Mean price (Ecus/kg)	7.77	6.20	8.71	8.69

However, the distribution is different depending on product presentation: for whole fresh fish, there is a wide distribution between less than 4 and more than 10 Ecus per kg. On the other hand, the market segment is concentrated between a price of 8 to 10 Ecus per kg for steaks and fillets (Fig. 2).

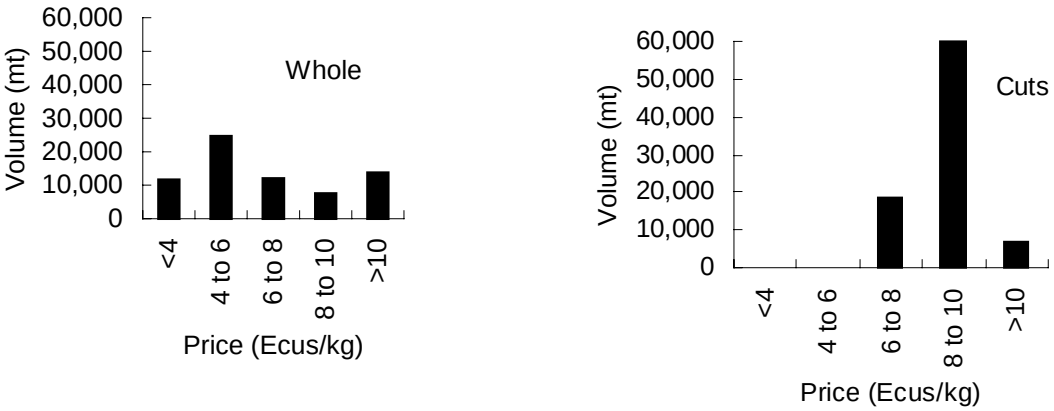

Fig. 2. Distribution of the price of fresh fish in relation with type of product (source: SECODIP, 1997).

The market share of cuts and prepacked fish being considered as promising, the adaptation of aquaculture to this segment must be considered.

Is aquaculture adapted to the prepacked and cuts market share?

The dominating role of salmon on this promising new French market segment highlights the capacity of aquaculture to take advantage of this opportunity. However, the marine fish farming industry with its two success-sea bass (*Dicentrarchus labrax*) and sea bream (*Sparus aurata*) has only focussed on the whole fish market segment. The production features of both species are described by Paquotte (1998): increasing production, decreasing selling price, directed to a connoisseur population, absence of flesh processing and absence of outlets outside Europe. Such characteristics are far away from those of the standard fish market. Furthermore, recent attempts of Greek producers to rear new fish species follow similar trends.

In order to answer to the consumer demand and to capture the new promising market segment of standard fish, aquaculture products must have regards to the specific requirements given by the supermarkets: supply regularity and homogeneity of characteristics. Fish species candidate for aquaculture must be carefully selected using classical parameters such as high growth potential and good adaptation to captivity, but also more specific characteristics fitting well with this new market segment such as low production cost, high ratio of flesh and easiness to be filleted. Compared to the whole fresh market, the knowledge of the species presents a lower interest for the standard market. The consumer rather emphasizes on the availability of fish flesh at a low cost and easy to cook. As a consequence, the substitutability between species is greater for the standard market than for the connoisseur's one.

The large success of tilapia (*Tilapia* sp.) on the US market illustrates the development capacity of this segment. In 1998, 27,820 mt have been imported, with a market share estimated to 45,000 mt. At

present among species reared in aquaculture, tilapia is the third importation in volume after shrimp and salmon. American consumers enjoy the filets of tilapia, lacking bones and taste but ready cooked (Morineau, 1999).

Is pollack a good candidate to the market for prepacked and cuts?

The targeted market share being defined, the selection method is tested on pollack. Because of its high quality flesh, its high maximal size (>1 m), its rapid growth in the wild (Dupuy *et al*., 1989) and the possibility to collect breeders from the wild, pollack was selected as a candidate for aquaculture. First rearing attempts of pollack have been carried out from 1994, in IFREMER, Centre of Brest. This phase did not aim at optimizing the rearing cycle of pollack, but at carrying out a few experiments in order to point out the major biological parameters with respect to their impact on production costs. Main results recorded from this previous phase are presented in Table 4.

Table 4. Main biological results recorded during the rearing testing phase of pollack (from Parfouru, 1996; Suquet *et al*., 1996)

Parameter	Result
Number of eggs/kg of female	626,000
Egg diameter (mm)	1.2
Mean hatching rate (%)	17
Survival at day 30 (%)	From 3 to 28
Mean weaning survival rate (%)	28
Mean weight 18 months after hatching (g)†	400
Best protein content of pellets (%)†	50 or 55
Food conversion rate†	0.98
Optimal rearing temperature (°C)††	16

†Water temperature between 13 and 18°C, fed *ad libitum* on pellets.
††According to mathematical model of Muller-Feuga, 1990.

Biological results recorded in captivity and in the wild can be divided in intrinsic features, mainly depending on the species and rearing ones, mainly depending on the state of the techniques, the latter being more easily improved. Intrinsic characteristics sustain pollack candidature for aquaculture: a high fecundity comprised between that of sea bass (Devauchelle and Coves, 1988) and that of turbot (*Psetta maxima*, Fauvel *et al*., 1993), a high growth capacity similar to that recorded in turbot in private farms and a first sexual maturation only observed in three year old animals (Parfouru, 1996). The optimal rearing temperature can be considered as high on the French Atlantic coast. However, a rapid growth was recorded in the range of 12 to 18°C.

Problems are recorded for rearing characteristics, suggesting the need of further investigations. Low hatching rate and larval survival were observed. This could be explained by the low quality of the spawn and the need to adapt the larval rearing techniques to the specific requirements of pollack. A low weaning survival was also recorded. In cod, also belonging to the gadoid family, this problem was decreased by increasing the weight of larvae at the beginning of the weaning phase (Ottera *et al*., 1994). Then, an opacity of cornea was frequently observed in animals weighing more than one kilo (J. Le Gal, pers. comm.), suggesting a low adaptation of pellets composition to pollack requirements.

Pollack flesh is well appreciated. However, the whole sale price of fresh pollack is low, ranging from 2.3 to 4.6 Ecus per kg. A technico-economic analysis showed that the production cost could be comprised between 5.6 and 7.2 Ecus/kg when pollacks are reared in raceways and between 2.7 and 3.2 Ecus/kg when reared in cages (Parfouru, 1996). Because of this cost, the market segment of whole fresh pollack will not be easily won by aquaculture. As a consequence, pollack flesh must be

processed and transformed in steaks and fillets, so corresponding to the promising standard market segment. Fillets yield of pollack is similar to those of other farmed fish species (Table 5).

Table 5. Fillet yield of some farmed fish species (source: FIOM, 1987)

Species	Fillet yield (fillet/gutted weight: %)
Atlantic salmon	45
Pollack	46
Rainbow trout	45
Sea bass	–
Sea bream	46
Turbot	–

Substitutability between different fish species has been suggested, taking into account the large increase of salmon sales on the French fish market. It can only be considered on a standard market share and not on a connoisseur one. A preliminary survey (Parfouru, 1996) conducted in Finistère (North part of Brittany), showed that the white flesh of pollack cannot be substituted to the pink one of salmonids but only to that of other gadoids such as cod or European hake (*Merluccius merluccius*).

Conclusion

The selection method proposed in this paper consists in four steps, allowing a first appraisal of the potential interest for aquaculture of new marine fish species: (i) identification of the most promising market share; (ii) selection of a fish species regarding the possibility to collect breeders or juveniles in the wild and biological characteristics available in the literature; (iii) preliminary experiments carried out in order to precise some biological features absent from the literature; and (iv) technico-economic analysis.

The standard fresh fish market share has been identified as a promising segment on the French market. Aquaculture must now pay attention to this new evolution of consumer's behaviour. This soaring market share will be captured by creating for these new products an image of practicality, low cost and good adaptation to lifestyle. Quality must not be forgotten, a survey conducted in 1996 and covering four countries of the European Union (France, UK, Germany and Italy) showing freshness remains essential in the choice of consumers (COPA-COGECA, 1997).

Adapted to pollack, the selection method shows the interest of this species for aquaculture: because of its high growth, its good quality flesh and its capacity to be filleted, pollack seems adapted to the standard market share. The general decrease of white fish production also sustains its candidature for rearing. However, further investigations are needed to improve survival during the hatchery phase, allowing to precise the specific requirements of pollack for aquaculture. Furthermore, a consumption analysis of the white fish market must be performed, describing the consumer's behaviour.

All these elements will allow a "safety plunge" in the aquaculture of new marine fish species and especially of pollack.

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