Available online at www.sciencedirect.com
ScienceDirect
Aquaculture 262 (2007) 86–94
Aquaculture
www.elsevier.com/locate/aqua-online

Effects of dietary factors, stocking biomass and domestication on the nutritional and technological quality of the Eurasian perch *Perca fluviatilis*

Guillaume Mairesse *, Marielle Thomas, Jean-Noël Gardeur, Jean Brun-Bellut

Unité de Recherche Animal Fonctionnalités des Produits Animaux, Nancy-Université INRA, MAN, 34 rue Sainte Catherine, 54000 Nancy, France

Received 22 February 2006; received in revised form 3 October 2006; accepted 4 October 2006

Abstract

The *ante mortem* determinism of the quality components in fish is multivariate. Among the various influencing factors, the effects of (i) rearing biomass, (ii) dietary features and (iii) domestication process on the technological and nutritional variables in perch *Perca fluviatilis* here were studied using two-levels fractional factorial design 2^{4-1} (resolution IV). This work allowed identifying two main factors, i.e. domestication and diet composition, which influence both technological and nutritional variables. Domestication was the parameter showing the greatest effect on both filleting yield (FY) and total saturated fatty acids (SFA) content, whereas diet composition chiefly influenced viscerosomatic index (VSI) and total poly- and mono-unsaturated fatty acids (PUFA and MUFA) contents. Domesticated fish exhibited higher FY (42.8%) and total SFA (25.1% of total fatty acids or FA) content than wild fish (FY = 40.1%, total SFA = 22.9%). Concerning the effect of food composition, diet including only fish oil as lipid source (FO) induced higher VSI than diet including vegetable oil (FV) VSI = 8.8% *vs* 7.4%, respectively). Moreover, FV diet induced higher n-6 PUFA but lower n-3 PUFA contents in fillets than did the FO diet (total n-6 PUFA = 6.3% *vs* 5.4% and total n-3 PUFA = 52.6% *vs* 55.2% of total FA respectively). FV fish fillets had significantly higher total MUFA (17.7% of total FA) contents in muscle than FO fish (14.8%). Concerning this last variable, domestication played only a role in interaction with diet composition. With FO diet, no difference in total MUFA content between wild and domesticated perch was noticed. However, total MUFA content increased with FV diet and was significantly higher in fillets of wild fish (18.7% *vs* 16.6% of total FA for domesticated). No effect of either feeding rate or initial biomass on the body composition was noticed. In addition, perivisceral fat content was not influenced by any treatment.

Keywords: Domestication; Technological quality; Nutritional quality; Diet composition; Fractional factorial design; *Perca fluviatilis*

1. Introduction

Within a context of production optimisation, a preliminary step aiming at the identification of the primary factors that worked on the determinism of the quality of fish is essential (screening approach). During the rearing process, many *ante mortem* factors could interact on the fish quality. Among those, dietary factors and rearing density/biomass have been determined as the primary influential factors. Indeed, dietary factors (food intake and quality) work on growth, colour, nutritional and technological qualities (Regost et al., 2001; Mathis, 2003; Mathis et al., 2003). Furthermore, the substitution of fish oil by different vegetable oil sources is presently a

* Corresponding author. Tel.: +33 3 83 30 28 41; fax: +33 3 83 32 36 13.
E-mail address: Guillaume.Mairesse@lsa-man.uhp-nancy.fr (G. Mairesse).

0044-8486/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.aquaculture.2006.10.004

high stake for sustainable aquaculture (Opsahl-Ferstad et al., 2003). However, such practices have species-specific response and differently affect the fish body composition. For instances, Regost et al. (2003) showed that the inclusion of vegetable oil has no effect on fillet yield of turbot (*Psetta maxima*), yet significantly reduced growth. However, in rainbow trout (*Oncorhynchus mykiss*), no effect on growth was reported (Kaushik et al., 1995). Besides the dietary factor, the stocking density/biomass has an effect on many parameters such as social interactions, food availability, water quality, and can influence *in fine* the different components (e.g. nutritional, technological or organoleptical) of quality. For example, density alters the growth of perch *Perca fluviatilis* (Mélard et al., 1996; Kestemont et al., 2003) and European sea bass *Dicentrarchus labrax* (Papoutsoglou et al., 1998). Nevertheless, density has no effect on colour in arctic charr *Salvelinus alpinus* (Metusalach et al., 1997). In addition, rearing practices, which imply voluntary or involuntary selection/domestication process, can lead to a quality difference either between wild and farmed populations or between populations from different farms (Fleming and Einum, 1997; Enders et al., 2004a). For example, domestication/selection process has been described as altering colour (Shikano, 2005), morphology (Enders et al., 2004b), technological yields (Argue et al., 2003; Neira et al., 2004) and nutritional composition (Weber and Fausch, 2003). Consequently, the *ante mortem* determinism of fish quality is clearly multifactorial and thus it may be interesting to study simultaneously several factors and their possible interactions.

Table 1
Food composition (mean±standard deviation)

	FV	FO
Protein content (%)	44.6±0.4	44.8±0.4
Lipid content (%)	17.2±0.2	13.9±0.2
FA composition (% total FA)		
C14:0	6.1±0.1	3.7±0.2
C16:0	16.4±0.0	10.2±0.2
C18:0	2.6±0.0	2.0±0.0
Total SFA	26.2±0.1	16.7±0.3
C16:1	6.8±0.0	4.4±0.1
C18:1	12.5±0.1	6.3±0.0
C20:1	5.3±0.1	2.4±0.1
C22:1	7.0±0.1	4.3±0.2
Total MUFA	31.9±0.1	18.2±0.2
C18:2n-6	6.0±0.1	2.8±0.0
C20:4n-6	1.1±0.0	2.0±0.2
Total n-6 PUFA	7.6±0.2	5.2±0.2
C20:5n-3	18.6±0.1	41.2±0.1
C22:6n-3	11.4±0.2	15.8±0.3
Total n-3 PUFA	34.1±0.2	59.9±0.2

Measurements in triplicates. FV = Diet fish+vegetable oils; FO = Diet fish only oil; SFA = Saturated fatty acids (FA); MUFA = Mono-unsaturated FA; PUFA = Poly-unsaturated FA. Only FA>1% were presented.

In this context, the 'one-variable-at-time" approach is impossible. In the present study, we used a multifactorial approach (reduced factorial design) to study the effects of (i) dietary factors (quality and quantity), (ii) domestication (domesticated fish referred here to fish that have just been reared for several generations), and (iii) biomass on technological and nutritional variables. This method is usually regarded as a method for screening experiment and is particularly adapted to the present problematic. The biological model used is the Eurasian perch, *P. fluviatilis*, which is currently considered as a possible species for diversification of inland aquaculture, mainly to the European market (Acerete et al., 2004). In addition, this fish presents a high variability of quality regarding to the geographic origin, rearing systems (Mairesse et al., 2005, 2006).

2. Materials and methods

2.1. Rearing conditions and tested factors

In the present study, the effects of four factors at two levels on the quality of fish were tested. The first studied factor was the domestication level of the population. Eggs of the domesticated fish (F6 breeders) came from the PerciTech Company (Switzerland). Eggs of wild fish were collected in the Lake Geneva. The batches were separately incubated in our laboratory facilities. Larvae and juveniles were reared until 50 g (mean weight) according to Jourdan (1999), i.e. at optimal feeding rate (Fiogbe and Kestemont, 2003); diet=Ecolife, Biomar Company (Prot./Lip.: 45/16%). The second factor was the origin of lipid sources. The first level is "FV diet": fish+vegetable oils mixture (commercial diet Ecolife, BioMar Company, precise composition not communicated); and the second one is "FO diet": fish oil source as the only lipids source (fish meal=60%, wheat gluten=31.9%, fish oil=7.5%, vitamins and minerals=0.6%) (Table 1). However, due to an undesirable systematic variation in the total lipid content of the diets, the factor "origin of lipid source" overlaps with the dietary lipid content. Consequently, this factor will be thereafter entitled "Diet composition". The third factor was the feeding rate. Two feeding rates were carried out: (i) normal feeding rate (FR nor.) determined by Mathis (2003) as giving the best growth performances in our experimental units and simulating the practice used in farms and (ii) FR nor. −30%, this allowed a restriction of food availability without stopping the growth of fish. At