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Muscle cellularity and flesh quality of wild and farmed sea bass, *Dicentrarchus labrax* L.

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Abstract

Sea bass (*Dicentrarchus labrax* L.) has been widely farmed in the last decade. In order to a better understanding of the final quality of this species, muscle cellularity and quality parameters of the flesh were studied on 14 specimens of wild and 11 farmed Atlantic sea bass, at approximate commercial size (weight 350 g, length 32 cm). White muscle cellularity was evaluated by means of the following parameters: number and diameter of muscle fibres, as well as the muscle fibre size distribution, throughout the total cross-section of the flesh. To ascertain the flesh quality, several physico-chemical parameters (moisture, protein, total fat, fatty acids, hydroxyproline, collagen and pH) were analyzed, and textural mechanical properties (hardness, springiness, chewiness, cohesiveness, gumminess) were determined objectively with a texturometer.

Muscle cellularity was different between both groups, such that muscle fibre density was higher for wild specimens ($p<0.05$). Farmed sea bass showed a higher content of moisture and protein ($p<0.01$), and a lower flesh pH, and hydroxyproline and collagen contents ($p<0.01$). Despite of the fact that the total fat did not show significant differences between both populations, saturated and monounsaturated fatty acids were significantly higher in farmed than in wild sea bass, whereas wild fish showed a higher content of polyunsaturated fatty acids ($p<0.05$). No significant differences were found in the total content of ω−3 fatty acids between both groups. All textural properties were significantly higher in wild than in farmed fish ($p<0.001$), all of them show a positive and significant correlation with muscle fibre density, pH, hydroxyproline and collagen contents. Changes in these parameters determined marked differences in the flesh quality of wild and farmed sea bass, whereas no relationship was found between muscle cellularity and nutritional composition of the sea bass. According to our results, genetic factors as well as the influence of extrinsic factors such as feeding regimes and/or exercise may determine significant variations of some structural and flesh quality parameters of the sea bass.

Keywords: Sea bass; Muscle cellularity; Texture; Flesh quality; Fatty acids; ω−3; PUFA; MUFA; SAFA

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1. Introduction

Muscle tissue is the main edible portion of fish and responsible of their nutritional value. Fish axial muscle is segmentally arranged into myotomes, with two main fibre types grouped into two muscle layers: the superficial (red muscle) and deep (white muscle) layers (Rowlerson et al., 1985; Scapolo et al., 1988; Veggetti et al., 1990). Also, an intermediate, thin layer (pink muscle) is usually present between them (Mascarello et al., 1986; López-Albors et al., 1998). Fish muscle growth commonly occurs by two possible mechanisms: hypertrophy and hyperplasia of muscle fibres. Hypertrophic growth occurs throughout post-embryonic life until muscle fibres reach a functional maximum diameter (Egginton and Johnston, 1982). Hyperplastic growth of muscle fibres refers to the increase in muscle fibre number due to the recruitment of new fibres. The rates of muscle fibre hypertrophy and hyperplasia to reach a given girth vary between species and different strains of the same species (Weatherley et al., 1979) and can be affected by controlled rearing conditions such as diet (Kiessling et al., 1991), exercise training (Johnston and Moon, 1980; Totland et al., 1987), and temperature (Nathanailides et al., 1996; Johnston et al., 1998, 2003a; Ayala et al., 2000, 2001; López-Albors et al., 2003). Hence, the cultivation of fish may produce a wide range of numbers and diameters of muscle fibres in the flesh (muscle cellularity), which is related to the growth history of the fish. Also, in wild fish the environmental and nutritional conditions may determine different muscle cellularities associated to their particular lifestyle.

White muscle cellularity is an important determinant of the textural characteristics of the flesh (Fauconneau et al., 1993; Hurling et al., 1996). Several studies have found a relationship between muscle fibre size and the firmness of the flesh (Hatae et al., 1990; Hurling et al., 1996), which could also influence on the taste and processing characteristics of the flesh (Johnston, 1999). This has already been demonstrated for the Atlantic salmon (*Salmo salar*, L.) where the firmness of smoked fillet and colour measured by Roche *Salmo*Fan™ were positively correlated with the muscle fibre density (Johnston et al., 2000a).

Flesh quality is a complex set of characters involving intrinsic factors such as texture, chemical composition, colour, fat content (Fauconneau et al., 1995), and is heavily influenced by extrinsic factors such as pre- and post-slaughter handling procedures (Dunajski, 1979; Gjerdrem, 1997). The quality characteristics of the sea food products, as of any other food items, are strictly dependent on factors involved in the production processes and vary between markets. The composition and sensorial parameters differ in general between wild and farmed fish (Børresen, 1992; Netteleton and Exler, 1992). The chemical parameters of wild fish are strongly influenced by the sea environmental conditions, which determine the nutrients availability. In farmed fish, feeding with artificial diets provides a wide range of nutrients and this fact, not only determines fish growth rate but flesh composition, in particular the lipid content, which may be quantitatively and qualitatively modified (Izquierdo et al., 2003). However, flesh protein content is less influenced by external feeding since it is mainly dependent on intrinsic factors such as the fish species, variety and size (Børresen, 1992; Shearer, 1994; Huss, 1999). Concerning the organoleptical properties, a high content of fat in the farmed fish could lead to a lower texture, but texture is also related to other factors, such as collagen content of the flesh and the muscle fibre size (Johnston et al., 2000a).

Farmed seafoods have an advantage over wild-caught fishery products since they are produced and harvested under controlled conditions, and for this reason the hazards associated with fish consumption might be reduced. Fish farming has registered a worldwide rapid expansion in the recent decades (FAO, 1998), showing the sea bass (*Dicentrarchus labrax*, L.) production a great increase. Murcia is the main sea bass farming region in Spain, with the 44% of the Spanish production (García-García et al., 2001). Parallelly to a higher production, the consumption of sea bass in Europe has significantly increased due to a lower price in markets and its desirable aroma and quality. Recently, the differences in the chemical composition between wild and farmed sea bass of Greece and Italy have been reported by Alasalvar et al. (2002) and Orban et al. (2002), however, no previous studies have compared