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Comparison of wild and cultured sea bass (*Dicentrarchus labrax*) quality

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ABSTRACT

Chemical composition, nutritional value and other physico-chemical parameters of sea bass from two different geographical areas (Greece and Spain) and from aquaculture and wild origin were studied. Farmed and wild fish differ in proximate composition, colour, and especially in texture, fatty acids and free amino acids (FAAs) profiles. Flesh of wild fish was firmer, which could be attributed to their lower fat content and higher level of activity. Cultured fish showed a higher content of monounsaturated fatty acids and lower of saturated and polyunsaturated fatty acids (PUFAs). Within the PUFA group, $n-3$ fatty acids were predominant in wild sea bass, while $n-6$ were more abundant in farmed fish. Some FAAs related to the characteristic flavour of fish, such as glutamic acid, aspartic acid, alanine, and glycine were more abundant in cultured sea bass. No differences between fish from both farms were found, due to the similar composition of the feed used.

1. Introduction

In Europe, the demand for fresh sea bass (*Dicentrarchus labrax*) has increased over the past 15 years because of its nutritional value, taste, aroma, and overall quality. For this reason, many farmers on the Mediterranean coast have expanded their annual production; sea bass being one of the main cultured fish species in this area (Kyrana & Lougovois, 2002).

Quality of fish flesh is the result of a complex set of characteristics involving factors such as chemical composition, texture, and colour, among others. These quality parameters are influenced by intrinsic (fish species, size, and sexual maturity) and extrinsic factors (source of nutrients, season, water salinity, temperature, etc.) (Børrensen, 1992). The nutritional value and organoleptic characteristics of fish are especially affected by rearing conditions, so that composition and sensory parameters are expected to be different between wild and farmed fish (Børrensen, 1992). In farmed fish, artificial diets provide a wide range of nutrients, which not only determine fish growth rate but also flesh composition, in particular the lipid content, which may be quantitatively and qualitatively modified (Izquierdo et al., 2003).

Some authors have reported differences in the organoleptic characteristics between farmed and wild fish (Grigorakis, Taylor, & Alexis, 2003). However, in other studies these differences have not been found (Farmer, McConnell, & Kilpatrick, 2000). In general, cultured fish have been reported to have a softer texture and milder flavour than wild fish, which has been related to differences in muscle structure, proximate composition and the aromatic compounds profile (Johnston et al., 2006). In addition, farmed fish have the advantage of being reared and harvested under controlled conditions, so that hazards associated with fish consumption can be more easily controlled. It is of considerable interest for the farming industry and consumers to be aware of the compositional and nutritive differences between wild and cultured fish.

The aim of this work was to study chemical composition, nutritional value and physico-chemical parameters of sea bass (*D. labrax*) from different geographical areas and from aquaculture and wild origin.

2. Materials and methods

2.1. Materials

In this work, 27 sea bass from three different origins (two farmed and one wild) were studied, nine fish from each origin. Two different farms supplied aquacultured fish, one farm was set in eastern coast of Spain (Mediterranean Sea, Spain), and the other in Serifos Island (Egean Sea, Greece). In both cases, farmed specimens were reared in net cages in the sea farms fed commercial diets and harvested with about 24 months old. The composition of the commercial feed used in both farms is shown in Table 1. Wild specimens were captured off the Mediterranean coast of Spain; all other factors during capture were not controlled or assessed. Sampling was performed in June 2006.

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Table 1
Proximate composition and fatty acids profile of the diets used in both farms (Greece (G) and Spain (S)).

	G	S
Proximate composition (g/100 g)		
Moisture	9	9
Lipid	18	14
Protein	46	48
Ash	8	9
Crude fibre	1.5	1.7
Fatty acid composition (g/100 g total fatty acids)		
14:0	5.0	5.2
15:0	0.5	0.4
16:0	16.0	15.3
18:0	5.0	4.7
16:1 $n-7$	5.7	5.3
18:1 $n-9$	17.9	14.9
20:1 $n-9$	3.3	2.2
18:2 $n-6$	11.0	11.5
18:3 $n-3$	2.6	1.4
18:4 $n-3$	1.6	1.6
20:1 $n-9$	3.3	2.2
20:5 $n-3$	7.3	8.3
20:4 $n-6$	0.6	0.9
22:1 $n-9$	3.2	2.9
22:5 $n-3$	0.8	0.4
22:6 $n-3$	9.5	10.1
$\sum n-3$	21.8	21.8
$\sum n-6$	12.1	11.9
$\sum n-3$: $\sum n-6$	1.80	1.83

Fish were slaughtered by immersing in ice-cold water (hypothermia) and delivered to the laboratory (whole) within 72 h of harvesting, packed in separate insulated polystyrene boxes with ice-water slurry.

All chemicals were obtained from Panreac (Barcelona, Spain) and Merck (Darmstadt, Germany), except for fatty acid and amino acid standards, which were supplied by Sigma–Aldrich–Fluka Company Ltd. (St. Louis, MO, USA).

2.2. Analytical methods

2.2.1. Biometric measurements

Upon arrival at the laboratory fish were individually weighted (TW) and measured to determine standard length (SL) and depth or maximum height (H). Length was measured from the tip of the mouth to the end of the upper lobe of the caudal fin (total body length), and height consisted of a vertical measurement of the maximum height of the body excluding the fins. Condition factor (CF) was calculated as $CF = (TW/SL^3) \times 100$.

2.2.2. Proximate composition and mineral content

Moisture, lipid, protein, and ash contents were assayed by AOAC Methods 950.46, 991.36, 928.08, and 920.153, respectively (AOAC, 1997).

For mineral composition (Na, Mg, Ca, K, P, Fe, Cu, Mn, and Zn) the ashed samples were dissolved in 1 mL of hydrochloric acid (35% v/v Suprapur®, Merck), filtered with cellulose filter paper (Whatman no. 1, Whatman International Ltd., Maidstone, UK), diluted to an appropriate concentration for each elemental, and finally analysed (except for P) with a Perkin–Elmer AA spectrophotometer mod 3110 (Norwalk, CT, USA). The content of P was analysed by UV–Vis spectrophotometry using a CE 10320 series UV–Vis spectrophotometer (Cecil Instruments Ltd., Cambridge, UK).

2.2.3. pH, water activity (a_w), and water holding capacity (WHC)

Muscle pH was measured in a fish/water (1:10, w/v) homogenate, using a pH-meter (Crison Instruments, SA, Alella, Barcelona, Spain). Water holding capacity of fish muscle was determined by centrifugation at 500g for 10 min at 10 °C, as proposed by Gómez-Guillén, Montero, Hurtado, and Borderias (2000). Water activity was assessed on minced samples of fish using an Aqualab® apparatus model CX-2 (Decagon Devices Inc., Pullman, WA, USA).

2.2.4. Total volatile basic nitrogen (TVB-N)

Total volatile basic nitrogen was determined by steam distillation according to the method described by Malle and Tao (1987).

2.2.5. Texture

Texture of farmed and wild sea bass was evaluated by shear force and compression test using a TA-XT2® Texture Analyser (Stable Micro System, Surrey, UK), with a load cell of 250 N, and Texture Exponent 32 v1.0 (Stable Micro Systems) software. All textural measurements were performed using $20 \times 20 \times 10$ mm pieces from the dorsal muscle of the fish fillet. Fish samples were only skinned for the shear test. For the compression study, the texture analyser was equipped with a 7.5 cm diameter flat-ended cylindrical plunger. The plunger was pressed downwards at a constant speed of 1 mm s^{-1} into the sample until reaching 50% of sample height. For shear force test, the instrument was equipped with a HDP/BS Warner–Bratzler test cell (Stable Micro Systems), which sliced the samples perpendicularly to the muscle orientation at a constant speed of 1.0 mm s^{-1}.

2.2.6. Colour determination

Instrumental colour analyses were performed with a Minolta colorimeter CM-3600d (Minolta, Osaka, Japan) using the D_{65} light source and a 10° observer.

2.2.7. Fatty acids analysis

Fatty acids were determined by gas chromatography–mass spectrometry (GC–MS). The extraction of the total lipid was carried out according to the method described by Folch, Less, and Sloane-Stanley (1957). Transmethylation was carried out using methanol/hydrochloric acid/dimethoxypropane (40:4:1.6, v/v/v). The derivatized fatty acid methyl esters (FAMEs) were analysed using a gas chromatograph/mass spectrometer (GC–MS) Finnigan TRACE MS (TermoQuest, Austin, TX, USA), according to the method described by Fuentes, Fernández-Segovia, Escriche, and Serra (2009).

2.2.8. Free amino acids (FAAs) analysis

This analysis was undertaken by HPLC with pre-column derivatization using phenylisothiocyanate (PITC), according to the method described by Bugueño, Escriche, Serra, and Restrepo (1999) and modified by Fuentes et al. (2009).

All analyses described above were performed in triplicate.

2.3. Statistical analysis

Statistical treatment of the data was performed using the Statgraphics Plus version 4.0 (Rockville, MD, USA). One-way analysis of variance (ANOVA) was used to establish significant differences between the tree origins. The method used for comparison was the LSD test (least significant difference) with a significance level of $\alpha = 0.05$. A simple regression analysis was performed in order to find a possible correlation between pH and WHC. The data were fitted by a linear model, $Y = a + bX$, where Y represents the pH and X is the WHC.