Somatic indexes, chemical-nutritive characteristics and metal content in caught and reared sharpsnout seabream (*Diplodus puntazzo*)

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ABSTRACT

The aim of this study was to compare some somatic indexes, chemical-nutritive characteristics and the contents of some metals (Pb, Cu, Cr and Zn) in the whole body and fillet from caught and reared sharpsnout seabream (Diplodus puntazzo). The fish came from three different conditions: reared in marine cages (R), captured in a natural lagoon (L) and in the Mediterranean sea (S). Thirty fish per group, divided into three weight categories (100±15.3, 200±18.7 and 300±20.4g), were used for the trial.
Reared sharpsnout seabream showed higher amounts of celomatic fat (3.41%, 2.43%, 0.21%, respectively for R, L and S) and total lipid (13.86%, 11.23% and 5.06% respectively for R, L and S), and lower moisture (64.14%, 65.54%, 71.53%) and protein (17.73, 19.03 and 19.17%) than those caught in the lagoon and sea. The whole body of reared fish contained lower amounts of lead (0.70, 0.75 and 0.97mg/kg, respectively for R, L and S), copper (0.15, 0.38, 0.25mg/kg) chrome (2.19, 3.52, 3.77mg/kg) and higher zinc contents (63.47, 53.42, 47.31mg/kg) than caught fish.
Fatty acids from sharpsnout seabream fillets showed a high lipid quality as confirmed also by low values of Thrombogenic index (0.36, 0.30 and 0.22, respectively for L, S, R) and Atherogenic index (0.47, 0.42 and 0.33, respectively for L, S, R). Reared sharpsnout seabream showed lower saturated fatty acid values (26.44%, 32.21%, 34.85%, respectively for R, S, L) and higher oleic acid amount (21.61%, 19.15%, 11.99%, respectively for R, L and S). The subjects captured in the sea had a higher arachidonic acid content (5.44%, 1.76%, 0.59%, respectively for S, L, R).
In the weight categories, the 100g subjects, showed higher incidence of viscera (VSI: 4.32%, 3.12% and 2.92%, respectively for 100, 200 and 300g) and liver (HIS: 2.20%, 1.97%, and 1.77%, respectively for 100, 200 and 300g), higher moisture (69.49%, 67.03%, 64.69%) and lower lipid rate (7.64%, 10.18%, 12.32%).

Key words: Diplodus puntazzo, Somatic indexes, Chemical composition, Fatty acid profile, Metals.

RIASSUNTO
INDICI SOMATICI, CARATTERISTICHE CHIMICO-NUTRITIVE E CONTENUTO DI ALCUNI METALLI NEL SARAGO PIZZUTO (*DIPLODUS PUNTAZZO*) ALLEVATO E PESCATO IN MARE E LAGUNA

Scopo del presente studio è stato quello di valutare alcuni indici somatici, la composizione chimica, il tenore di alcuni minerali (Pb, Cu, Cr, Zn) e gli acidi grassi dei lipidi di sarago pizzuto (Diplodus puntazzo) di diversa provenienza: allevato in gabbie galleggianti (R) e catturato in mare (S) o in laguna (L). La prova è stata effettuata su 30 soggetti per gruppo, ognuno formato da 3 categorie di peso (100±15,3, 200±18,7 e 300±20,4 grammi). I saraghi di allevamento hanno presentato maggiore incidenza del grasso celomatico (3,41, 2,43 e 0,21%, rispettivamente per i gruppi R, L e S) e del grasso corporeo (13,86, 11,23 e 5,06 rispettivamente per i gruppi R, L e S) rispetto agli altri due gruppi. Per contro, sono risultati più bassi i valori di umidità (64,14, 65,54 e 71,53%, rispettivamente per i gruppi R, L e S) e proteine (17,73, 19,03 e 19,17%, rispettivamente per i gruppi R, L e S). I soggetti di allevamento si sono caratterizzati anche per aver fatto registrare contenuti inferiori di Piombo (0,70, 0,75 e 0,97mg/kg, rispettivamente per i gruppi R, L e S), rame (0,15, 0,38 e 0,25mg/kg, rispettivamente per i gruppi R, L e S) e cromo (2,19, 3,52 e 3,77mg/kg, rispettivamente per i gruppi R, L e S) e superiori di zinco (63,47, 53,42 e 47,31mg/kg, rispettivamente per i gruppi R, L e S). La composizione acidica del grasso del muscolo del filetto ha fatto emergere una elevata qualità dei lipidi del sarago pizzuto indipendentemente dalla sua provenienza, con valori molto bassi degli indici di trombogenicità (0,36, 0,30 e 0,22 rispettivamente per i soggetti L, S e R) e di aterogenicità (0,47, 0,42 e 0,33, rispettivamente per i soggetti L, S e R). I soggetti di allevamento hanno presentato valori significativamente più bassi di acidi grassi saturi (26,44, 32,21 e 34,85%, rispettivamente per i soggetti R, S e L) e più elevati di acido oleico (21,61, 19,15 e 11,99%, rispettivamente per i soggetti R, L e S). I soggetti di mare si sono distinti per l'elevato contenuto di acido arachidonico (5,44, 1,76 e 0,59%, rispettivamente per i soggetti S, L e R). Tra le maggiori differenze rilevate in funzione del peso, da segnalare una maggiore incidenza nei soggetti di 100 grammi degli indici viscerosomatico (4,32, 3,12 e 2,92%, rispettivamente per i soggetti di 100, 200 e 300 grammi) ed epatosomatico (2,20, 1,97 e 1,77%, rispettivamente per i soggetti di 100, 200 e 300 grammi), un maggior contenuto di umidità (69,49, 67,03 e 64,69%, rispettivamente per i soggetti di 100, 200 e 300 grammi) e una minore percentuale dei lipidi del corpo (7,64, 10,18 e 12,32%, rispettivamente per i soggetti di 100, 200 e 300 grammi).

Parole chiave: Diplodus puntazzo, *Indici somatici, Composizione chimica, Acidi grassi, Metalli.*

Introduction

In the fish farming industry there is increasing interest to diversify production, which is still currently focused on sea bass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*), whose market value has decreased in proportion to the increase in the supply and acquisition by foreign products of considerable market shares. Among the possible candidates for mariculture, sharpsnout seabream (*Diplodus puntazzo*) has been shown to spawn in captivity and to be managed in hatchery conditions (Micale *et al.*, 1996; Firat *et al.*, 2005). The results of recent research are quite encouraging, and indicate a considerable increase in sharpsnout seabream production in the near future (Orban *et al.*, 2000; Hernàndez *et al.*, 2001; Favaloro *et al.*, 2002; Bonaldo *et al.*, 2004).

Nevertheless, it is evident that this forecasted increased production will have to be supported by further investigation on nutritive and breeding requirements of this species and close examination of sharpsnout seabream flesh quality. This aspect has great commercial importance given that reared fish generally have different chemical-bromatologic characteristics, compared to their caught counterparts. This work aims to compare the chemical-bromatologic characteristics of fished sharpsnout seabream with those of intensively reared subjects.

Material and methods

Trials were based on 90 fish captured in the sea (S), in a lagoon (L) or reared in marine cages (R). Sharpsnout seabream (SSB) specimens were divided into three weight categories (100±15.3, 200±18.7 and 300±20.4g), with 30 fish in each group. Reared individuals came from floating cages in the Gulf of Olbia (Sardinia) and were between 12 and 30 months old, fed on commonly-used non-specific fish feedstuff. The diet ingredients were: fish feedstuff, oil seed products, oils and fats, cereal composites, BHT, vitamin integration 7000U.I/kg vit. A, 1300U.I/kg vit. D3, 140mg vit E, and 7.5mg copper (ico) sulphate monohydrate. Proximate composition of the diet was analysed according to AOAC (2000) (Table 1).

Sea-captured subjects were caught in the proximity of the north-western coast of Sardinia, while lagoon fish were captured in a coastal lagoon sited along the north-eastern cost of Sardinia with a lower sea-level, different temperature and salinity compared to open sea and permanent fish-catching structures called lavorieri. All the subjects of the two groups were captured in October 2004.

All the fish underwent biometric and chemical analysis. Data from total body weight, and length as well as viscera, liver, mesenteric and perinephric fat weights were collected and used to calculate the condition factor (CF), hepatosomatic (HSI), viscerosomatic (VSI) and celomatic fat (CFI) indexes. For whole body composition, the gastrointestinal content was removed and then each fish was minced and freeze-dried. Moisture, protein, lipids and ash contents were analysed according to AOAC (2000). Whole body mineral analysis was carried out on 10 fish per sea-captured, lagoon and reared group after mineralization in Microware ETON D (Millistone) using an Atomic Absorbance Spectrometer with graphite tube (SpectrAA20, Varian) according to the method proposed by Jorhem (1993) and using the following lamps: Zn: Hollow Cathode Lamp Varian, Wavelength 213.9; Cr: Multielement Lamp Varian, Wavelength 357.9; Cu: Multielement Lamp Varian, Wavelength 324.8; Pb: Hollow Cathode Lamp Photron, Wavelength 217.0. Data were processed using the Spectr AA 4.1 software.

Table 1. Proximate composition of diet (on wet weight).

		diet
Dry matter	g 100g^{-1}	91.8
Crude protein	"	45.8
Total Lipid	"	12.2
Ash	"	10.8
Gross energy	MJ kg^{-1}	19.4

The total lipids of muscles from 300 g fish were extracted according to the Folch method (1957). The fatty acid composition of the fillets was determined by gas chromatographic separation on fatty acid methyl esters (FAMEs), using a 30 m x 0.32 mm capillary column (Omegawax, Supelco Inc., Bellefonte, USA), hydrogen as carrier gas and flame ionization detection (ThermoQuest TRACE GC). FAMEs were identified by comparison of retention times of known standards.

The thrombogenic and atherogenic indexes according to Ulbricht and Southgate (1991) are as follows:

AI= C12:0+C14:0+C16:0/ΣMUFA+Σω6+Σω3

TI= C14:0+4* C16:0+C18:0/(0.5*ΣMUFA)+0.5* ω6+3*(ω3/ω6)

Data from biometric and chemical analysis and metal were analysed by ANOVA (SAS, 2000) using the model:

$$Y_{ijk} = \mu + S_i + W_j + SW_{ij} + \varepsilon_{ijk}$$

Table 2. Effect of origin and weight on the somatic indexes of *D. puntazzo.*

	Origin			Weight (g)				
	Reared	Lagoon	Sea	100	200	300	Interaction	SEM
n.	30	30	30	30	30	30		
CF	2.03^{A}	1.97^{AB}	1.89^{B}	1.89^{B}	2.02^{A}	1.98^{AB}	ns	0.03
HSI	2.05	1.95	1.95	2.20^{A}	1.97^{AB}	1.77^{B}	**	0.18
VSI	3.82^{A}	2.56^{B}	3.99^{A}	4.32^{A}	3.12^{B}	2.92^{B}	*	0.57
CFI	3.41^{A}	2.43^{B}	0.21^{C}	1.74^{B}	2.00^{AB}	2.31^{A}	**	0.53

*A,B,C: P<0.01; *: P<0.05; **: P<0.01, ns: P>0.05.*
CF, condition factor: 100 × (body weight / fork length^3).
HSI, hepatosomatic index: 100 × (liver weight / body weight).
VSI, viscerasomatic index: 100 × (viscera weight / body weight).
CFI, celomatic fat index: 100 × (celomatic fat weight / body weight).

while data from fatty acid composition were analysed using the model:

$Y_{ijk} = \mu + S_i + \varepsilon_{ijk}$

where Y is the single observation; μ is the general mean; S is the source effect (i = sea, lagoon and farmed); W is the weight effect (j = 100, 200 and 300 grams); SW is the interaction between the effects; and ε is the error.

Results and discussion

As emerges from the somatic indexes (Table 2), significant differences (P<0.01) were observed in the condition factor both between the sea fish and reared fish (1.89 and 2.03, respectively), and among the 100g and 200g fish (1.89 and 2.02, respectively).

The values observed in this research differ slightly from those reported (2.13 and 2.24) by Bonaldo *et al.* (2004) in 134g and 150g sharpsnout seabream. However, it is worth noting that the condition factor is positively correlated with body weight, increasing from 1.2 in young specimens to 2 in commercial size fish (Hernandez *et al.*, 2003). Further, it has been suggested that the condition factor increase associated with the weight gain could be indicative of a decreasing relative length growth in fish, while the growth rate of skeletal muscle has been shown to be higher than that of the whole body (Goolish and Adelman, 1988).

The hepatosomatic index (HSI) varies significantly when measured against body weight. 100g subjects showed higher values (P<0.01) than 300g fish (2.20 *vs* 1.77), agreeing with Hernandez *et al.* (2003) who stated that sharpsnout seabream HSI progressively decreases with the age. By contrast, Weatherley and Gill (1983) reported that, with the exception of visceral fat, the weight of all major tissues (liver, gut and skin) increases more slowly than body weight.

The viscerosomatic index (VSI) showed differences depending on fish origin with significantly lower values for lagoon individuals (2.56 *vs* 3.82 *vs* 3.99 respectively for lagoon, reared and sea). In accordance with the findings of Weatherley and Gill (1983) the VSI also depended on weight, with higher values for the lighter specimens (4.32 *vs* 3.12 *vs* 2.92, respectively for 100g, 200g and 300g body weight).

The CFI showed marked differences between the sea-captured subjects (0.21) vs farmed (3.41) fish, confirming what is normally observed when comparing caught and reared fish. The latter often present higher fat accumulation due to higher energy intake.

Table 3 shows the effect on sharpsnout seabream body composition of different weight and origin. Caught fish had lower whole body fat contents (5.06 *vs* 11.23 *vs* 13.86%, respectively for sea, lagoon and farmed) than the other two groups and higher water contents (71.53 *vs* 65.54 *vs* 64.14%; respectively for sea, lagoon and farmed). Total lipid content in farmed fish was lower than those (14.4 - 16.5) found by Hernandez *et al*. (2001) in sharpsnout seabream fed a diet with similar chemical characteristics (Crude Protein 44.33; Crude fat 12.12). Bonaldo *et al*. (2004) report substantially higher fat values (21.9 and 22.2%) in sharpsnout seabream fed diets with higher fat content (31.1 and 29.2%), as well as lower whole body protein content (15.5%) than that resulting in this study (17.7%) and those reported (18.7-19.3%) by Hernandez *et al*. (2001). As regards the muscle fat content in the reared sharpsnout seabream, it seems to have a similar tendency to that reported for sea bass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus auratus*). In these species, reared fish generally shows from 2 to 5 times higher values than caught specimens (Haard, 1992; Orban *et al*., 1996; Lanari *et al*., 1999; Orban *et al*., 1999; Poli *et al*., 1999, 2001). This phenomenon may be attributed to the reduced energy intake on the part of caught compared to farmed fish and not to differences in energy expenditure, given that the latter reduce feed efficiency and growth with little effect on body composition (Shearer, 1994).

The protein content is considered to be pre-determined by the genetic characteristics of the species (Shearer, 1994) and unaffected by the diet (Morris, 2001). Hence, the differences noted in protein content of the body (19.17 *vs* 19.03 *vs* 17.73%, respectively for sea, lagoon and farmed) are probably due to the combined effect of changes in the fat and moisture percentage of the body. The body weight influenced the moisture content, which was lower for the heavier individuals (64.69 *vs* 67.03 *vs* 69.49%, respectively for

Table 3. Effect of origin and weight on the whole body proximate composition ($100g^{-1}$ wet weight) of D. puntazzo

	Origin			Weight (g)				
	Reared	Lagoon	Sea	100	200	300	Interaction	SEM
n.	30	30	30	30	30	30		
Moisture	64.14^{C}	65.54^{B}	71.53^{A}	69.49^{A}	67.03^{B}	64.69^{C}	**	2.22
Crude protein	17.73^{B}	19.03^{A}	19.17^{A}	18.96^{A}	18.31^{B}	18.67^{AB}	ns	0.22
Total lipid	13.86^{A}	11.23^{B}	5.06^{C}	7.64^{C}	10.18^{B}	12.32^{A}	**	1.90
Ash	$3.59B^{b}$	3.93^{Ba}	4.48^{A}	4.21^{a}	3.94^{ab}	3.85^{b}	ns	0.015

*A,B,C: P<0.01; a, b: P<0.05; **: P<0.01, ns: P>0.05.*

300g, 200g and 100g), and the fat content, higher for the heavier specimens (12.32 vs 10.18 and 7.64%, respectively for 300g, 200g and 100g). These two parameters were influenced by the origin/weight interaction. The ash content (3.85, 3.94 and 4.21%, respectively for 300g, 200g and 100g) and the protein content (18.67, 18.31 and 18.96%, respectively for 300g, 200g and 100g) differed slightly, albeit significantly.

Metal concentrations (Pb, Cu, Cr and Zn), analyzed in the whole body and reported as mg/kg of wet weight, are presented in Table 4. The origin influenced all four metals analyzed. Reared fish showed lower contents of Pb (0.70, 0.75 and 0.97mg/kg, respectively for farmed, lagoon, sea), Cu (0.15, 0.38, 0.25mg/kg, respectively for farmed, lagoon, sea) and Cr (2.19, 3.52 and 3.77mg/kg) and higher in Zn (63.47, 53.42 and 47.31mg/kg).

Pb values appear to be high for all three groups (the limit laid down by the EU, Official Journal of the European Union, 2005, for Pb content in fish fillets is 0.4mg/kg). However, it is worth noting that the intestine, kidney, gill and liver tend to accumulate the highest metal levels (Merlini and Pozzi, 1977; Somero *et al.*, 1977; Reichert *et al.*, 1979; Wagner and Boman, 2003; Kojadinovic *et al.*, 2007). Nevertheless, the high Pb levels found in reared fish suggests that it might be appropriate to indicate the Pb contents on the label of commercial diets.

The Cu levels observed in this study are low, reflecting low Cu levels in the environment where fish were captured or reared. Also Cr levels may be considered to be low, especially taking into account the tendency of Cr to be accumulated in the gill and in the kidney (Farag *et al.*, 2006). The higher Cr concentration in sea specimens seems to indicate the presence of significant amounts of this metal in the marine environment. Zn content was higher in farmed fish, probably reflecting the high Zn content in certain antifouling paints usually used in crafts and in submerged marine equipment.

Finally, the results of fatty acid composition appear very interesting from a nutritional point of view (Table 5). The low values of the atherogenicity index (0.42, 0.47 and 0.33, respectively for sea, lagoon and farm) and the very low thrombogenicity indexes (0.30, 0.36 and 0.22, respectively for sea, lagoon and farm) reveal a high poly-unsaturated fatty acids content in sharpsnout seabream fillets. Given that chicken flesh, strongly recommended by nutritionists, has atherogenicity and thrombogenicity index values respectively of 0.30 and 0.95 (Ulbricht and Southgate, 1991), the high lipid quality of this food for human consumption appears evident.

Table 4. Effect of origin on the whole body metal contents (mg/kg).

	Origin			
	Reared	Lagoon	Sea	SEM
n.	10	10	10	
Pb	0.70^{B}	0.75^{B}	0.97^{A}	0.014
Cu	0.15^{C}	0.38^{A}	0.25^{B}	0.004
Cr	2.19^{B}	3.52^{A}	3.77^{A}	0.18
Zn	63.47^{A}	53.42^{B}	47.3^{C}	23.05

A,B,C: P<0.01.

Farmed sharpsnout seabream showed the highest percentages of oleic (21.61% *vs* 19.15% *vs* 11.99%, respectively for reared, lagoon and sea) and linoleic acids (9.78%, 1.73%, 0.87%, respectively for

Table 5. Fatty acid composition of fillets (g of fatty acid $100g^{-1}$ of total fatty acids) of *D. puntazzo* of different origin.

Fatty acids	Reared	Lagoon	Sea	SEM
C 10:0	0.08^{B}	0.23^{A}	0.24^{A}	0.02
C 12:0	4.18^{A}	2.15^{B}	2.37^{B}	0.25
C 14:0	0.46^{B}	0.49^{B}	0.88^{A}	0.04
C 15:0	0.10^{B}	0.24^{B}	0.65^{A}	0.05
C 16:0	17.39^{B}	25.02^{A}	21.03^{B}	13.44
C 16:1n7	6.79^{Bb}	11.23^{A}	9.78^{ABa}	3.79
C 16:2n4	0.22^{B}	0.61^{A}	0.64^{A}	0.04
C 16:3n4	0.34^{B}	0.62^{ABb}	1.12^{Aa}	0.09
C 16:4n1	0.41^{ABa}	0.17^{Bb}	0.57^{A}	0.03
C 17:0	0.36^{B}	$0,78^{A}$	0.79^{A}	0.01
C 18:0	2.97^{B}	5.14^{A}	5.34^{A}	0.6
C18:1n9	21.61^{A}	19.15^{A}	11.99^{B}	6.86
C18:1n7	3.08^{B}	4.81^{AB}	7.01^{A}	3.55
C18:2n6	9.78^{A}	0.87^{Bb}	1.73^{Ba}	0.33
C18:2n4	0.19^{a}	0.09^{b}	0.18^{a}	0.003
C18:3n6	0.12^{B}	0.31^{AB}	0.42^{A}	0.02
C18:3n4	0.21	0.15	0.22	0.006
C18:3n3	1.40^{A}	0.51^{B}	0.58^{B}	0.02
C18:4n3	1.11^{B}	2.30^{Aa}	1.54^{ABb}	0.26
C18:4n1	0.17^{A}	0.02^{B}	0.05^{B}	0.002
C20:0	0.19^{C}	0.39^{A}	0.30^{B}	0.003
C20:1n9	3.36^{A}	1.73^{B}	0.94^{C}	0.13
C20:3n9	0.24^{C}	1.81^{A}	1.03^{B}	0.3
C20:2n6	0.35	0.23	0.37	0.2
C20:3n6	0.22^{B}	0.17^{B}	0.38^{A}	0.01
C20:4n6	0.59^{B}	1.76^{B}	5.44^{A}	2.65
C20:3n3	0.14	0.17	0.23	0.01
C20:4n3	1.05^{ABb}	1.49^{Aa}	0.93^{B}	0.05
C20:5n3	5.27	5.33	5.4	1.43
C21:5n3	0.38^{A}	0.19^{B}	0.19^{B}	0.005
C22:0	0.09^{Ba}	0.06^{Bb}	0.20^{A}	0.006
C22:1	2.15^{A}	1.51^{B}	0.84^{C}	0.17
C22:4n6	0.34^{B}	0.39^{B}	1.02^{A}	0.08
C22:5n3	2.91^{B}	5.53^{A}	3.78^{B}	1.04
C22:6n3	11.01^{A}	3.66^{B}	10.83^{A}	8.49
C 24:0	0.04^{b}	0.14^{ab}	0.41^{a}	0.05
C24:1	0.11^{b}	0.30^{ab}	0.85^{a}	0.33
SFA	26.44^{C}	34.85^{A}	32.21^{B}	2.51
MUFA	37.09^{A}	38.74^{A}	31.39^{B}	5.66
PUFA	37.46^{A}	26.41^{B}	36.40^{A}	0.17
n3	23.28^{A}	19.19^{B}	23.22^{A}	4.97
n6	11.40^{A}	3.74^{B}	9.36^{A}	5.09
n3/n6	2.05^{B}	5.13^{A}	2.49^{B}	1.67
DHA/EPA	2.09	2.08	2.02	0.89
EPA/AA	8.95^{A}	3.04^{B}	1.00^{C}	1.06
IA	0.33^{B}	0.47^{Aa}	0.42^{Ab}	0.001
IT	0.22^{C}	0.36^{A}	0.30^{B}	0.001

A,B,C: $P<0.01$; a, b: $P<0.05$.

reared, sea and lagoon). Although oleic and linoleic acids are not normal constituents of the marine food chain, they are present in plant oils and plant ingredients found in feedstuff for farmed fish and accumulate largely unchanged in the lipids of marine fish due to their reduced capacity for chain elongation and desaturation (Sargent *et al.*, 2002). Thus, the higher amount of these fatty acids in farmed fish is probably related to their dominance in commercial fish feedstuff. It is difficult to explain, instead, the high amount of oleic acid found in lagoon fish. This could partly be attributed to changes in the food chain, compared to the open sea, occurring in a confined environment, given also the omnivorous habits of the species. Caught sharpsnout seabream contained much lower amounts of monounsaturated fatty acids ($P<0.01$) compared to the other two groups (31.98%, 38.74% and 37.09%, respectively for sea, lagoon and reared), partly due to the lower presence ($P<0.01$) of oleic acid. Arachidonic acid levels were higher (5.44, 1.76 and 0.59, respectively for sea, lagoon and farm) in caught fish, agreeing with previous findings (Rueda *et al.*, 1997; Serot *et al.*, 1998; Grigorakis *et al.*, 2002). The levels of arachidonic acid are generally lower in reared fish because feedstuffs commonly used in aquaculture contain minimal amounts of this fatty acid (Sargent *et al.*, 1999). Levels of PUFA n-3 were high in all the three groups (23.22, 19.19 and 23.28%, respectively for sea, lagoon and farmed), confirming that the marine environment is an excellent source of PUFA n-3 and that the farmed subjects were fed a diet supplying high amounts of polyunsaturated n-3 fatty acids. Similar values are reported by Rondan et al. (2004) in sharpsnout seabream fed a diet with 22.47% of n-3 polyunsaturated fat acids.

No significant differences were noted for the n-6 FA content between sea (9.36%) and farmed (11.40%) fish, while the lagoon specimens showed clearly lower values (3.74%). Accordingly, the highest n3/n6 ratio was detected in the lagoon individuals (5.13, 2.49 and 2.05, respectively for lagoon, sea and farm).

Conclusions

The three different groups of sharpsnout seabream analyzed in our study showed important differences, especially between sea fish and farmed fish. In particular, farmed sharpsnout seabream showed higher celomatic fat indexes and whole body fat contents compared to sea fish. Therefore, from this point of view, sharpsnout sea bream seems to have a similar behaviour to other commonly reared fish species (sea bass, sea bream, trout). As regards fatty acid composition, farmed specimens presented lower levels of arachidonic acid and saturated fatty acids, and higher oleic acid levels than caught ones. In general, with reference to the atherogenicity and thrombogenicity indexes, normally taken into consideration to evaluate the lipid quality, farmed fish showed a better fatty acid profile compared to caught ones. However, it is well known that in reared fish it is possible to modify/improve lipid quality through the diet. As regards metal content, the observed differences among the three groups suggest that in caught fish it is easier to find higher concentrations of metals. Nevertheless, the high Pb and Zn contents in reared fish suggest the advisability of conducting more accurate controls of the characteristics of the water, equipment and diets.

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