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Nutritional traits of dorsal and ventral fillets from three farmed fish species

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Abstract

Dorsal and ventral fillet portions (DP and VP, respectively) of European sea bass (*Dicentrarchus labrax*, ESB), gilthead sea bream (*Sparus aurata*, GSB), and rainbow trout (*Oncorhynchus mykiss*, RBT) were analysed for proximate constituents, and fatty acid composition and content.

Moisture and lipid content differentiated DP from VP in all species. Significant differences emerged between DP and VP from ESB for MUFA, PUFA, and DHA contents. The *n*6/*n*3 ratio ranged from 0.22 (DP in RBT) to 0.38 (VP in GSB). The highest hypocholesterolaemic/hypercholesterolaemic fatty acid ratio pertained to DP and VP from RBT, and the lowest peroxidisability index to VP from GSB and ESB. The index of nutritional quality for EPA + DHA was always higher in VP than in DP, that of RBT being especially interesting because it is associated with a lower energy value than that from ESB and GSB.

Keywords: Flesh composition; Fatty acid profile; European sea bass; Gilthead sea bream; Rainbow trout

1. Introduction

European sea bass (*Dicentrarchus labrax* Linnaeus 1758), gilthead sea bream (*Sparus aurata* Linnaeus 1758), and rainbow trout (*Oncorhynchus mykiss* Walbaum 1792) are widely appreciated and consumed in Italy. An increase in production has been registered in recent years for both sea bass and sea bream, up to 17,300 ton/year on the whole. Rainbow trout have been farmed for a long time, with production levels totalling 44,000 ton/year (ISMEA, 2003).

Usually, these species are consumed fresh; however, a consumers' trend has been observed towards processed foods with a high service content (i.e., easy-to-use culinary products, with shorter cooking times) (ISMEA, 2002). Among these foods, processed rainbow trout products are notable for number, from frozen or smoked fillets to fish burgers. Recently, frozen fillets of sea bass and sea bream have made their appearance on the market.

Lipid content of farmed fish flesh is significantly higher than that found in wild specimens of the same species (Orban, Nevigato, Di Lena, Casini, & Marzetti, 2003; Sağlik et al., 2003; USDA, 2004), which is in relation to feeding and rearing practices. Lipid distribution in fish muscle varies greatly, depending on species, type of muscle, and sampling site within muscle (Ackman, 1967). In Atlantic salmon, for example, a non-uniform distribution of lipid throughout the whole fillet was observed (Katikou, Hughes, & Robb, 2001). In rainbow trout, variations in lipid and moisture content were found both in cranio-caudal and in dorso-ventral directions (Fjellanger, Obach, & Rosenlund, 2001). Such dif-

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ferences need to be addressed in sampling planning in view of nutritional analyses (Fjellanger et al., 2001), sensory evaluation with either trained panellists or plain consumers (Lawless & Heymann, 1999), and possibly storage trials.

Recently, an optimal utilisation of large farmed rainbow trout has been devised by Mørkøre, Hansen, Unander, and Einen (2002) which entails using fillet portions for different kinds of technological processing according to their chemical composition and mechanical properties.

The aim of the present study was to highlight compositional differences between dorsal and ventral portions of fillets from sea bass, sea bream and rainbow trout farmed and marketed in Italy. It was verified if and for which nutrients dorsal and ventral portions could be differentiated, and if the dorso-ventral variation affected the three species to the same extent. The fatty acid content of the two portions was focussed on, with special attention paid both to some indices of nutritional and technological quality, and to the percentage contribution that each portion could give to the daily requirements of some fatty acids.

2. Materials and methods

2.1. Raw material and processing

Seawater-reared European sea bass ($n = 5$) and gilthead sea bream ($n = 5$), and freshwater-reared rainbow trout ($n = 5$) were randomly selected from stocks of ready-for-sale animals obtained from Italian commercial farms producing for the domestic market. Fish were slaughtered in water and ice, packed in polystyrene boxes, and covered with ice. Boxes of fish were immediately transported to the laboratory where fish samples were weighed, measured, and processed. The length was measured from the tip of the mouth to the end of the upper lobe of the caudal fin (total body length). The peritoneal cavity was opened along a ventral midline incision. The entire visceral mass, including liver and perivisceral fat, was weighed as a whole. Liver was isolated and weighed. An incision along the dorsal fin up to the caudal fin, and another incision behind the opercula, excluding lateral and ventral fins, were made to separate both fillets from each carcass. Each fillet was weighed with skin, then cut along the insertion line of the ribs to obtain a dorsal and a ventral fillet (Fig. 1). After skinning, the two dorsal fillets from each fish were joined, their sum being named "dorsal portion" (DP), and weighed. The same was done with the two ventral fillets, which yielded a "ventral portion" (VP). In addition, a calculation was made of the percentage of body weight represented by each of the following: viscera (viscerosomatic index, VSI), liver (hepatosomatic index, HSI), fillets with skin (fillet yield), and skinned dorsal and ventral portions (dorsal and ventral yield). Both the dorsal and the ventral portions obtained from each fish were finely diced, thoroughly mixed, and homogenised in three 5 s bursts with a Multiquick System ZK100 food processor (Braun GmbH, Kronberg, Germany).

2.2. Proximate and fatty acid composition

Samples were immediately analysed in duplicate for moisture, ash, and total nitrogen using AOAC methods N. 950.46B, 920.153, and 928.08 (AOAC, 2000), respectively. Total protein was calculated from Kjeldahl nitrogen using a 6.25 conversion factor. Total lipids were extracted in duplicate from 5 g of each homogenised sample, following the method of Folch, Lees, and Sloane-Stanley (1957) and calculated gravimetrically. The extracted lipids were resuspended in chloroform/methanol (2/1; v/v), added 1% of butylated hydroxytoluene (BHT), and transferred to a previously nitrogen-purged screw-cap test tube, which was stored in a freezer at −20 °C before gas chromatographic analysis. Total lipids were transesterified using methanolic sulphuric acid (1%), according to the procedure described by Christie (1989). Chromatographic analyses were carried out with a GC Varian 3380 (Varian Inc., Palo Alto, CA, USA) equipped with a flame ionisation detector (FID) and operated with a split ratio of 20:1. The column was a DB-23 J&B (30 m × 0.32 mm i.d., 0.25 μm coating thickness; Agilent Technologies, Palo Alto, CA, USA). The injector and detector temperatures were 230 and 300 °C, respectively. Oven temperature was programmed from 150 to 230 °C at 5 °C/min, then held for 6 min, for a total run time of 22 min. High purity nitrogen was selected as carrier gas at a flow rate of 2 ml/min. Chromatographic air and hydrogen (300 and 30 ml/min, respectively) were supplied to the FID. Methyl esters were identified by comparing the retention time of the unknowns with those of known fatty acid

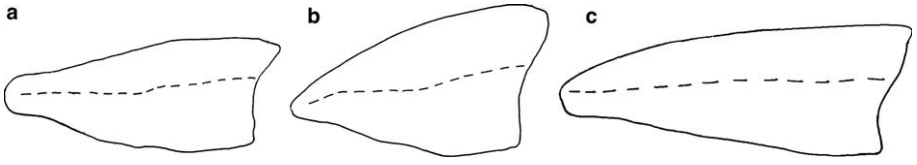

Fig. 1. Insertion line of ribs in European sea bass (a), gilthead sea bream (b), and rainbow trout (c).

methyl ester (FAME) standards (Sigma–Aldrich Corporation, St. Louis, MO, USA). The fatty acid content was reported as percentage of individual FAME based on total FAME present in the injected sample. Quantification was carried out by normalisation and transformation of the area percentage to g/100 g of edible portion, using the lipid conversion factor (fatty fish) method described by Greenfield and Southgate (1992).

2.3. Statistical analyses

Tissue expressed as a relative percentage of body weight, as well as proximate composition and fatty acid composition (% total FAME) were arcsin-transformed before statistical analysis. Both the transformed and the untransformed data (body lengths and weights, tissue and organ weights, fatty acid contents as g/100 g of edible portion) were subject to analysis of variance (ANOVA) as follows: one-way ANOVA for biometric data and yields of fish, the "between-group" factor being the species under examination; two-way ANOVA for proximate composition according to a "between group – within subjects" approach, with site (dorsal, ventral) as the "within subjects" (repeated measure) factor; one-way ANOVA both for the fatty acid composition (site as the repeated measure factor) and for the fatty acid content (species as the between group factor). Means were separated at, or below, the 5% probability level using the Scheffé post hoc test. All statistical computation was performed using the Statistica® software package (Release 5, 1997; StatSoft Inc., Tulsa, OK, USA).

3. Results and discussion

3.1. Biometric data and yields

The differences between marine species and rainbow trout in terms of weight of viscera, liver, and fillets should be related to the different size of the selected fish (Table 1). VSI and HSI for sea bass, sea bream, and rainbow trout were 13.03a, 7.44b, 14.01a ($P < 0.001$), and 1.89a, 1.71ab, 1.46b ($P < 0.05$), respectively. In sea bass, VSI was higher and HSI was slightly lower than the values found by Poli et al. (2001) and Orban et al. (2002). On the other hand, HSI of sea bream, and VSI and HSI of rainbow trout were comparable to literature data (Caballero et al., 2002; Geri et al., 1998; Grigorakis, Alexis, Taylor, & Hole, 2002; Grigorakis, Taylor, & Alexis, 2003; Jobling, Koskela, & Savolainen, 1998).

The fillet yield was significantly different between sea bass and rainbow trout, the sea bream value falling in-between (Table 1). Nevertheless, the three species did not differ as to the yield of DP and VP. The fillet yield found for rainbow trout was similar to that obtained by Caballero et al. (2002) from fish averaging 700 g of body weight whereas in sea bass and sea bream the fillet yield was lower in comparison with the values obtained by Poli et al. (2001) and Geri et al. (1998). Furthermore, Poli et al. (2001) found a higher fillet yield and a lower incidence of viscera in sea bass weighing more than 500 g.

3.2. Proximate composition

DP moisture contents were significantly different in sea bream and sea bass, although both the marine species did not differ from rainbow trout (Table 2). Furthermore, the three species did not show any significant differences in DP protein, lipid, and ash contents. DP lipid contents of sea bream was twice as high as those of sea bass and rainbow trout, even though the differences between species were not statistically significant, which could be ascribed to a certain dispersion of the data. Possibly for the same reason, VP lipid content of sea bass was not significantly different from those of sea bream and rainbow trout, although the sea bass value was almost double that of rainbow trout. Moreover, rainbow trout VP differed significantly from that of sea bass in protein and ash contents, and from that of sea bream in moisture and lipid contents.

Within species, DP was significantly different from VP in moisture and lipid contents (Table 2). In general these two components are inversely related in fish flesh, as found by Katikou et al. (2001) and Fjellanger et al. (2001). Differences between DP and VP were less pronounced or non-significant for protein content, whereas ash content differed between DP and VP only for sea bass. The mean ratio between VP and DP as to the lipid content was 2.92 for sea bass, 1.68 for sea bream and 1.66 for rainbow trout. To our knowledge, the literature is devoid of data with which the proximate composition of DP and VP from sea bass, sea bream, and rainbow trout could be compared. Studies by Fjellanger et al. (2001) showed that in rainbow trout fillets the lipid content tends to increase following the cranio-caudal direction, whereas this trend seems to be less pronounced in the dorso-ventral direction.

3.3. Fatty acid composition

In normalised terms (i.e., each fatty acid as a percentage of total FAME), sea bass, sea bream, and rainbow trout shared the same three fatty acids as the most represented, although with a different order (Table 3). In sea bass, palmitic acid (C 16:0) was the main fatty acid, followed by oleic acid (C 18:1 *n*9), and docosahexanoic acid (C 22:6 *n*3, DHA). In sea bream, the predominant fatty acid was oleic acid, followed by palmitic acid and DHA. In rainbow trout, DHA was the most represented, followed by palmitic acid and oleic acid, which had the second and third place, respectively, in DP,

Table 1
Biometric data and yields of fish

Trait[A]	Sea bass	Sea bream	Rainbow trout	MSE	*P*
Total body length (TBL, cm)	26.56b	24.40b	33.88a	1.75	***
Body weight (BW, g)	225.80b	273.21b	518.90a	3256	***
Viscera (VW, g)	29.28b	20.49b	72.96a	79.7	***
Liver (LW, g)	4.19b	4.69b	7.59a	1.15	***
Fillet weight (FW, g)[B]	103.68b	130.72b	260.76a	677	***
Dorsal portion (DP, g)[C]	51.87b	62.06b	113.91a	145	***
Ventral portion (VP, g)[C]	36.47b	48.62b	94.42a	140	***
Fillet yield (FY, %)[D]	45.70b	47.73ab	50.55a	0.0006	*
Dorsal yield (DY, %)[D]	22.80	22.60	22.11	0.0003	ns
Ventral yield (VY, %)[D]	16.08	17.72	18.20	0.0003	ns

Values are means of five fish for each species.
[A] ***$P \leqslant 0.001$; *$P \leqslant 0.05$; ns = not significant; mean values in the same row followed by different letters differ significantly (*Scheffé*, $P \leqslant 0.05$).
[B] Fillet with skin.
[C] Flesh without skin.
[D] FY = FW × 100/BW; DY = DP × 100/BW; VY = VP × 100/BW.

Table 2
Proximate composition of fish fillets (g/100 g edible portion)

Trait[A]	Site[B] (Si)	Species (S)			MSE	*P*		
		Sea bass	Sea bream	Rainbow trout		S	Si	S*Si
Moisture	D	x 75.60a	x 70.72b	x 75.40ab	0.80	***	***	***
	V	y 68.31ab	y 65.91b	y 73.02a				
Protein	D	x 19.5	x 19.4	20.3	0.16	**	***	ns
	V	y 17.7b	y 18.1ab	19.3a				
Lipid	D	y 4.45	y 8.58	y 4.00	1.91	***	***	***
	V	x 12.99ab	x 14.43a	x 6.62b				
Ash	D	x 1.26	1.29	1.44	0.005	***	***	ns
	V	y 1.06b	1.22ab	1.27a				

Values are means of five fish for each species.
[A] ***$P \leqslant 0.001$; **$P \leqslant 0.01$; ns = not significant; mean values in the same row followed by different letters differ significantly; mean values within a column and trait preceded by different letters differ significantly (*Scheffé*, $P \leqslant 0.05$).
[B] D = dorsal portion; V = ventral portion.

and the reverse in VP. In sea bass and rainbow trout, the fourth fatty acid was eicosapentaenoic acid (C 20:5 *n*3, EPA), and the fifth was linoleic acid (C 18:2 *n*6, LA). This order was reversed in sea bream.

Much more statistically significant differences between DP and VP as to the fatty acid composition of flesh lipids emerged for sea bass than for sea bream and rainbow trout (Table 3). Sea bass DP was significantly richer in *n*3 polyunsaturated fatty acids (PUFA) in general, and in DHA in particular, whereas sea bass VP was richer in monounsaturated fatty acids (MUFA) and in *n*6 PUFA. The *n*3 highly unsaturated fatty acids (HUFA) in DP and VP of sea bass were 90% and 87% of *n*3 PUFA, respectively, as against 71% and 66% of total PUFA. The *n*3 HUFA of sea bream, which did not differ between DP and VP, were 87% of *n*3 HUFA and 64% of total PUFA. In rainbow trout the average value of *n*3 HUFA in the two portions was 92% of *n*3 HUFA and 75% of total PUFA.

Even though a direct comparison was not made between species, consideration should be given to the following: (a) the three species were similar for the percentage of saturated fatty acids (SFA); (b) the marine species presented a higher amount of MUFA than did rainbow trout; (c) rainbow trout showed the highest percentage of *n*3 PUFA and total PUFA; (d) sea bass and rainbow trout showed similar percentages of *n*6 PUFA, which were lower than the value found in sea bream. This was to be anticipated, given the much wider difference in lipid content found in sea bass between the two portions, hence the different percentages of triglycerides (TAG) and phospholipids (PL) expected in them (Opstvedt, 1984), as well as the different distribution of MUFA and PUFA, but not SFA, between TAG and PL (Kiessling et al., 2001; McClelland, Zwingelstein, Weber, & Brichon, 1995).

Experimental data available in the literature deal with the fatty acid composition of the fillet as a whole, mainly as an outcome of feeding trials (Caballero et al., 2002; De Francesco et al., 2004; Haliloğlu, Bayir, Nected Sirkecioğlu, Mevlüt Aras, & Atamanalp, 2004; Kiessling et al., 2001). Therefore a comparison between the values

Table 3
Fatty acid composition of fish fillets (% total fatty acid methyl esters)

Trait[A]	Sea bass				Sea bream				Rainbow trout			
	Dorsal	Ventral	MSE	*P*	Dorsal	Ventral	MSE	*P*	Dorsal	Ventral	MSE	*P*
C14:0	3.81	4.58	0.06	**	4.28	4.90	0.23	ns	4.29	4.18	0.45	ns
C15:0	0.46	0.51	0.001	+	0.49	0.52	0.001	ns	0.45	0.44	0.001	ns
C16:0	18.8	18.2	0.47	ns	18.0	17.9	2.06	ns	17.8	17.1	1.48	ns
C17:0	0.46	0.43	0.001	ns	0.41	0.42	0.0001	ns	0.38	0.38	0.001	ns
C18:0	3.77	3.28	0.04	*	3.68	3.34	0.04	+	3.87	3.75	0.02	ns
C22:0	tr	tr			tr	tr			tr	tr		
∑SFA[B]	27.6	27.2	0.96	ns	26.9	27.0	4.35	ns	26.8	25.9	3.99	ns
C14:1	0.18	0.21	0.0009	ns	0.19	0.22	0.0002	*	0.19	0.19	0.0005	ns
C15:1	0.29	0.17	0.0008	**	0.14	0.13	0.0003	ns	0.20	0.15	0.0007	*
C16:1	4.51	5.05	0.005	**	5.70	5.62	0.04	ns	5.14	5.35	0.10	ns
C17:1	0.29	0.31	0.0001	ns	0.34	0.35	0.0005	ns	0.30	0.25	0.009	ns
C18:1 *n*9	17.7	18.1	0.015	+	19.0	19.1	1.18	ns	17.3	18.1	0.24	*
C18:1 *n*7	2.48	2.62	0.0007	*	2.81	2.80	0.01	ns	2.73	2.79	0.01	ns
C20:1 (Σ isomers)	4.54	5.04	0.08	*	3.79	3.73	0.11	ns	2.74	2.96	0.06	ns
C22:1 *n*9	4.12	4.51	0.07	+	3.98	3.98	0.31	ns	2.38	2.71	0.20	ns
C22:1 *n*7	0.56	0.53	0.007	ns	0.70	0.57	0.0008	ns	tr	tr		
C24:1	0.46	0.46	0.009	ns	0.69	0.59	0.007	+	0.46	0.50	0.02	ns
∑MUFA[C]	35.1	36.9	0.32	**	37.3	37.0	1.94	ns	31.4	33.0	0.41	*
C18:2 *n*6	5.44	6.07	0.05	**	6.86	6.97	0.06	ns	5.06	5.39	0.02	*
C18:3 *n*6	0.21	0.22	0.0001	ns	0.22	0.21	0.0001	ns	0.23	0.27	0.002	ns
C20:2 *n*6	tr	tr			tr	tr			0.36	0.40	0.001	+
C20:4 *n*6	1.08	0.79	0.003	***	0.92	0.77	0.002	*	0.86	0.84	0.001	ns
C22:2 *n*6	tr	tr			tr	tr			0.39	0.46	0.007	ns
C22:5 *n*6	0.33	0.28	0.0001	*	tr	tr			tr	tr		
∑*n*6	6.95	7.31	0.02	*	8.14	8.15	0.14	ns	6.90	7.35	0.03	*
C18:3 *n*3	1.16	1.32	0.002	**	1.32	1.39	0.004	ns	1.15	1.18	0.002	ns
C18:4 *n*3	1.51	1.72	0.004	**	1.37	1.49	0.006	+	1.18	1.25	0.0005	**
C20:4 *n*3	tr	tr			tr	tr			0.91	0.95	0.006	ns
C20:5 *n*3	7.32	6.84	0.14	ns	5.48	5.34	0.35	ns	6.16	6.26	0.04	ns
C22:5 *n*3	1.35	1.28	0.002	+	2.79	2.53	0.10	ns	2.22	2.34	0.09	ns
C22:6 *n*3	14.8	11.6	0.27	***	12.4	10.8	2.06	ns	19.4	18.3	3.48	ns
∑*n*3 HUFA[D]	23.5	19.7	0.63	**	20.6	18.6	5.18	ns	28.7	27.8	5.57	ns
∑*n*3	26.2	22.8	0.65	**	23.3	21.5	5.72	ns	31.1	30.2	5.44	ns
∑PUFA[E]	33.1	30.1	0.61	**	31.5	29.7	7.22	ns	38.0	37.6	5.57	ns
∑Unidentified	4.12	5.72	1.23	ns	4.28	6.31	3.41	ns	3.76	3.46	0.23	ns
*n*6/*n*3	0.26	0.32	0.0002	**	0.35	0.38	0.001	ns	0.22	0.24	0.0004	ns
HH[F]	2.18	2.03	0.01	+	2.20	2.07	0.05	ns	2.40	2.46	0.06	ns
PI[G]	192	163	34	**	170	155	333	ns	227	220	318	ns

Values are means of five fish for each species.
[A] $***P \leqslant 0.001$; $**P \leqslant 0.01$; $*P \leqslant 0.05$; $^{+}P \leqslant 0.10$; ns = not significant (*Scheffé*, $P \leqslant 0.05$).
[B] SFA, saturated fatty acids.
[C] MUFA, monounsaturated fatty acids.
[D] *n*3 HUFA, highly unsaturated *n*3 fatty acids = (C 20:4 *n*3 + C 20:5 *n*3 + C 22:5 *n*3 + C 22:6 *n*3).
[E] PUFA, polyunsaturated fatty acids = (∑*n*6 + ∑*n*3).
[F] HH, hypocholesterolaemic/hypercholesterolaemic ratio = (C18:1 *n*9 + C18:2 *n*6 + C20:4 *n*6 + C18:3 *n*3 + C20:5 *n*3 + C22:5 *n*3 + C22:6 *n*3)/(C14:0 + C16:0).
[G] PI, peroxidisability index = (0.025 × monoenes) + (1 × dienes) + (2 × trienes) + (4 × tetraenes) + (6 × pentaenes) + (8 × hexaenes).

obtained in this trial and those reported in the literature is not straightforward. Nonetheless the fatty acid composition presented in Table 3 for sea bass and sea bream (both portions) fell within the range of values assembled from the literature for farmed fish fillets (Grigorakis et al., 2002; Orban et al., 2002, 2003; Sağlik et al., 2003). The portion of rainbow trout fillet analysed by Haliloğlu et al. (2004) for fatty acid composition was comparable to the rainbow trout DP considered in this trial. In freshwater-farmed rainbow trout of 200 g, Haliloğlu et al. (2004) found higher concentrations of SFA and *n*6 PUFA, and lower values of *n*3 PUFA in comparison with those reported in Table 3. These observations concur with those made by Kiessling et al. (2001), according to whom SFA decrease in rainbow trout muscle when age and body weight of fish increase.

The nutritional significance of the *n*6/*n*3 ratio has been underlined by Simopoulos (2003) as one of the

key elements for a healthy diet. The *n*6/*n*3 ratio was decidedly low in all the species, especially in rainbow trout, and differed significantly between DP and VP only for sea bass.

The ratio between hypocholesterolaemic and hypercholesterolaemic fatty acids (HH), suggested by Santos-Silva, Bessa, and Santos-Silva (2002) according to the current knowledge on the effects of specific fatty acids on cholesterol metabolism, did not differ between DP and VP for sea bream and rainbow trout, whereas in sea bass a marginally significant difference between the two portions was observed. The highest value of HH, which is the most desirable, was found in rainbow trout.

The peroxidisability index (PI), which was calculated according to Erickson (1992) to represent the relationship between the fatty acid composition of a tissue and its susceptibility to oxidation, supplied some information about the technological quality of fillet portions. Both DP and VP from rainbow trout showed the highest PI. In sea bass and sea bream PI was lower but only in the former was it significantly different between DP and VP. The high PI of rainbow trout flesh could be accounted for by considering that, in order to calculate this parameter, the relative weight of each unsaturated fatty acid has to be directly proportional to the number of its double bonds. As a consequence of the lower lipid content of rainbow trout flesh in comparison with those of marine species, the percentage of DHA was predictably higher in both the rainbow trout portions.

3.4. Fatty acid content and nutritional implications

The fatty acid content, expressed as g of fatty acids per 100 g of edible portion, was used to directly compare

Table 4
Fatty acid content of fish fillets (g/100 g edible portion)

Trait[A]	Dorsal					Ventral				
	Sea bass	Sea bream	Rainbow trout	MSE	*P*	Sea bass	Sea bream	Rainbow trout	MSE	*P*
C14:0	0.15b	0.33a	0.15b	0.004	***	0.53a	0.63a	0.25b	0.12	***
C15:0	0.02b	0.04a	0.02b	0.00004	***	0.06a	0.07a	0.03b	0.0001	***
C16:0	0.75b	1.38a	0.64b	0.05	***	2.12a	2.31a	1.02b	0.17	***
C17:0	0.02b	0.03a	0.01b	0.00002	***	0.05a	0.05a	0.02b	0.0001	***
C18:0	0.15b	0.28a	0.14b	0.002	***	0.38a	0.43a	0.23b	0.007	**
∑SFA[B]	1.08b	2.07a	0.97b	0.11	***	3.15a	3.49a	1.54b	0.39	***
C14:1	0.01b	0.01a	0.01b	0.000005	***	0.02a	0.03a	0.01b	0.00003	**
C15:1	0.01	0.01	0.01	0.00001	+	0.02a	0.02ab	0.01b	0.00003	*
C16:1	0.18b	0.45a	0.19b	0.009	**	0.60ab	0.74a	0.32b	0.03	**
C17:1	0.01b	0.03a	0.01b	0.00005	**	0.04a	0.05a	0.01b	0.00006	***
C18:1 *n*9	0.71b	1.46a	0.62b	0.06	***	2.13a	2.47a	1.08b	0.20	***
C18:1 *n*7	0.10b	0.22a	0.10b	0.001	***	0.31a	0.36a	0.17b	0.003	***
C20:1 (Σ isomers)	0.18b	0.29a	0.10 c	0.001	***	0.58a	0.48a	0.18b	0.007	***
C22:1 *n*9	0.16b	0.30a	0.09 c	0.001	***	0.51a	0.51a	0.16b	0.004	***
C22:1 *n*7	0.02	0.05	tr			0.05	0.06	tr		
C24:1	0.02b	0.05a	0.02b	0.00007	***	0.04b	0.08a	0.03b	0.0003	***
∑MUFA[C]	1.40b	2.88a	1.13b	0.22	***	4.27a	4.79a	1.98b	0.68	***
C18:2 *n*6	0.22b	0.53a	0.18b	0.008	***	0.71a	0.90a	0.31b	0.02	***
C18:3 *n*6	0.01	0.01	0.01	0.00004	ns	0.03a	0.03a	0.02b	0.00003	*
C20:4 *n*6	0.04b	0.07a	0.03b	0.0003	**	0.09a	0.10a	0.02b	0.0005	**
C22:2 *n*6	tr	tr	0.01			tr	tr	0.03		
C22:5 *n*6	0.01	0.02	tr			0.03	0.03	tr		
∑*n*6	0.28b	0.63a	0.24b	0.14	***	0.86a	1.06a	0.41b	0.04	***
C18:3 *n*3	0.05b	0.10a	0.04b	0.0005	**	0.16a	0.18a	0.07b	0.002	**
C18:4 *n*3	0.06b	0.11a	0.04b	0.0006	**	0.20a	0.20a	0.07b	0.002	**
C20:4 *n*3	tr	tr	0.03			tr	tr	0.06		
C20:5 *n*3	0.29ab	0.43a	0.22b	0.11	*	0.81a	0.70ab	0.37b	0.03	**
C22:5 *n*3	0.05b	0.22a	0.08b	0.002	***	0.15b	0.33a	0.14b	0.004	***
C22:6 *n*3	0.60	0.97	0.70	0.05	+	1.36	1.41	1.08	0.09	ns
∑*n*3 HUFA[D]	0.95b	1.62a	1.03ab	0.14	*	2.32	2.45	1.65	0.30	+
∑*n*3	1.05b	1.83a	1.12b	0.17	*	2.68	2.82	1.80	0.40	+
∑PUFA[E]	1.33b	2.46a	1.35b	0.29	**	3.53ab	3.88a	2.21b	0.67	*
∑Unidentified	0.17	0.30	0.20	0.01	ns	0.68a	0.82a	0.29b	0.02	***

Values are means of five fish for each species.

[A] ***$P \leqslant 0.001$; **$P \leqslant 0.01$; *$P \leqslant 0.05$; $^{+}P \leqslant 0.10$; ns = not significant; mean values in the same row under each heading followed by different letters differ significantly (*Scheffé*, $P \leqslant 0.05$).

[B,C,D,E] See footnotes in Table 3.

the DP or VP of the three species as meaningful sources of healthy fatty acids (Table 4). The content of most fatty acids in DP of sea bass and rainbow trout were quite similar, whereas the amount of most fatty acids in VP of the marine species differed markedly from those of rainbow trout. This was to be expected due to the widely different lipid contents of DP and VP of the three species. DP from sea bream was significantly richer in SFA, as well as in MUFA and *n*6 PUFA, than DP from sea bass and rainbow trout. This superiority was maintained in the content of α-linolenic acid (ALA) and *n*3 PUFA, whereas sea bream did not differ from sea bass in the content of EPA, and the difference between the three species was only marginally significant for the DHA content. On the whole, the *n*3 PUFA content of DP from sea bass was similar to that of DP from rainbow trout. As to VP, the content of SFA, MUFA, *n*6 and *n*3 PUFA did not differ significantly between sea bass and sea bream, being always higher than their counterparts in VP from rainbow trout. Still, the differences between the three species in DHA content were not significant, and those observed for the sum of *n*3 PUFA were only marginally significant, in spite of quite a lower figure for rainbow trout.

On the basis of these results, the EPA + DHA weekly requirement of an adult on a 2000 kcal diet, equalling 4.55 g as suggested by Simopoulos (2003), should be satisfied by 511, 325, and 495 g of DP from sea bass, sea bream, and rainbow trout, respectively. Both the higher lipid level and the higher EPA + DHA content of VP compared with DP within species account for the far lower amounts of VP (210, 216, and 314 g from sea bass, sea bream, and rainbow trout, respectively) that would be necessary to meet the same EPA + DHA weekly requirement. Adopting a more practical approach, those amounts would mean two regular fish burgers per week, containing 105–110 g each of minced VP from either sea bass or sea bream. The corresponding daily intake of $n-3$ HUFA (0.69 and 0.75 g, respectively, with two sea bass or sea bream burgers/week) would amply exceed the guideline recommendation jointly made by the British Scientific Advisory Committee on Nutrition and the Committee on Toxicity (SACN-COT, 2004) to attain a minimal daily intake of 0.45 g of $n-3$ HUFA, approximately contained in two portions of fish per week, of which one should be oily.

The index of nutritional quality (INQ) was calculated for EPA + DHA in DP and VP of each species using the formula suggested by Godber (1994). Briefly, a 100-g serving of either DP or VP was used to calculate a ratio of the achieved percentage of the EPA + DHA requirement (Simopoulos, 2003) to the percentage of a 2000 kcal intake. For all the species considered in this study, VP showed a higher INQ for EPA + DHA in comparison with DP (35 vs. 23 in sea bass, 32 vs. 27 in sea bream, 33 vs. 24 in rainbow trout). The INQ for EPA + DHA of VP from rainbow trout was associated with a lower energy value in comparison with the other species (137 kcal/100 g of edible portion against 188 kcal for sea bass and 202 kcal for sea bream).

4. Conclusions

On the basis of these results, remarkable differences in composition emerged between the dorsal and ventral fillet portions of farmed European sea bass, gilthead sea bream, and rainbow trout, even though these differences were not of equal importance for all of the nutrients considered. Among the three species, sea bass seemed to be the most affected by dorso-ventral differences, both in proximate and fatty acid composition. The three species shared some positive nutritional features, which were better highlighted by two health-related indices: the ratio between *n*6 and *n*3 PUFA and that between hypocholesterolaemic and hypercholesterolaemic fatty acids. Both of them revealed a certain superiority of rainbow trout over sea bass and sea bream.

By adopting the peroxidisability index as a measure of lipid susceptibility to oxidation, on the other hand, it was evident that the marine species, and their ventral portion in particular, retained superior technological properties.

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