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Near infrared reflectance spectroscopy (NIRS) characterization of European sea bass (*Dicentrarchus labrax*) from different rearing systems

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ABSTRACT - The present study aimed to predict by NIRS the proximate chemical composition and some carcass traits of sea bass coming from 11 farms with different rearing systems (extensive, intensive in land-based basins, sea cages) and located in northern (Friuli, Veneto), central (Tuscany) and southern (Puglia and Sicily) Italy. NIRS analysis of freeze dried sea bass fillets gave fairly good predictions of slaughter weight and fillet yield (R^2cv=0.48-0.55), while results for carcass yield were poor. NIRS analysis was highly predictive for the condition factor (R^2cv=0.790, SECV=0.09) and for water, ether extract and gross energy showing high correlations (R^2cv>0.90) with NIR spectral information and high accuracy (SECV=0.67%, 0.46% and 0.38 kJ/g for water, ether extract and energy, respectively). Crude protein prediction showed lower performance, even if still good, compared to previous variables (R^2cv=0.734, SECV=0.34). The score plot of principal component analysis showed intensively-reared sea bass separated from extensively reared fish.

Key words: Sea bass, NIRS, Chemical composition, Carcass traits, Rearing system.

Introduction - A high competition exists among several Countries in the Mediterranean area (Greece, Italy, Turkey, etc.) producing European sea bass (*Dicentrarchus labrax*) from aquaculture systems, which decreases market prices (Monfort, 2007). As for other food, the qualification and geographic differentiation could improve the image and price of cultivated sea bass. However, the analytical methods used for fish quality characterization are time-consuming and expensive. Although NIRS can provide wide and quick information on the quality of different fish species (Lin *et al*., 2006; Fasolato *et al*., 2008), it has been little used on European sea bass (Xiccato *et al*., 2004). The present study is part of a multidisciplinary research funded by the *Ministero delle Politiche Agricole e Forestali* (MIPAF) devoted to characterize European sea bass coming from 11 farms with different rearing systems (extensive, intensive in land-based basins or sea cages) distributed in different regions of Northern, Central and Southern Italy (see also Messina *et al*., 2009; Tulli *et al*., 2009). This paper presents the results of NIRS analysis to predict some carcass traits and proximate composition of sea bass and to possibly differentiate fish according to the rearing system.

Material and methods - Three hundred forty European sea bass were caught over a four-month period (December 2007-February 2008) in 11 Italian fish farms characterized by different rearing systems (three extensive lagoons, five intensive land-based basins, three sea cages) located in Northern (Friuli-Venezia Giulia and Veneto), Central (Tuscany) and Southern (Puglia and Sicily) Italy. The fish were killed by immersion in ice slurry and dissected within 24 hours after catch. The fillets were separated from about half of the caught fishes (n=164) and analysed for different physical, sensorial

and chemical characteristics (Messina *et al*., 2009; Tulli *et al*., 2009). Freeze-dried fillets were analysed for proximate composition and gross energy by AOAC methods and submitted to NIRS analysis in the 1100-2500 nm range with a 2 nm step by a monochromator spectrometer (InfraAlyser 500, Bran+Luebbe GmbH, Norderstedt, Germany). Absorbance spectra were collected and transformed in second derivative calculated over a 20-point smoothing segment (Unscrambler version 7.0, CAMO ASA, Trondheim, Norway). To predict some carcass traits (slaughter weight, carcass and fillet yield, and condition factor) and fillet chemical composition (water, crude protein, ether extract, and energy), calibration equations were calculated on transformed spectra by partial least square regression (PLSR) and full cross-validation using the procedures described by Xiccato *et al*. (2004). Prediction equations were evaluated in terms of coefficient of determination in calibration (R^2c) and cross-validation (R^2cv), standard error of calibration (SEC) and of cross-validation (SECV). The Principal Component Analysis (PCA) was used to evaluate spectral data according to origin.

Table 1. Carcass traits and fillet chemical composition (on fresh weight) of sea bass (no.=164).

	Minimum	Maximum	Mean	s.d.
Slaughter weight (SW), g	269	1032	588	169
Condition factor1	0.79	1.59	1.19	0.18
Carcass yield, % SW	80.0	93.2	86.9	2.5
Fillet yield, % SW	38.9	54.8	47.9	3.1
Water, %	61.3	79.7	71.4	3.7
Ether extract, %	0.17	16.0	7.3	3.6
Crude protein, %	16.2	26.8	19.5	0.9
Energy, kJ/g	4.09	10.96	7.54	1.56

[1]Condition factor=slaughter weight/total length[3]x100.

Table 2. Performance of calibration and cross-validation to predict some carcass traits and the chemical composition of sea bass fillets analysed by NIRS.

	Calibration			Full cross-validation	
	Factors	R^2cv	SEC	R^2cv	SECV
Slaughter weight, g	6	0.656	96	0.551	113
Condition factor	8	0.861	0.08	0.790	0.09
Carcass yield, %	1	0.239	2.06	0.221	2.09
Fillet yield, %	8	0.645	1.76	0.480	2.22
Water, %	3	0.968	0.62	0.964	0.67
Ether extract, %	2	0.986	0.42	0.984	0.46
Crude protein, %	9	0.845	0.25	0.734	0.34
Energy, kJ/g	3	0.945	0.36	0.939	0.38

Results and conclusions - Sea bass slaughter weight varied from 269 to 1032 g (Table 1) in the calibration set due to differences among farms and because two commercial sizes were collected in the same farm, when possible. Variation in other fish traits, like carcass and fillet yield and condition factor, depended both on the rearing system and the farm, as discussed by Tulli *et al*. (2009) and Messina *et al*. (2009). Chemical composition showed a wide variation, with ether extract from 0.17 to 16.0%, crude protein from 16.2 to 26.8% and energy from 4.09 to 10.96 kJ/g, depending on rearing system and feeding regime (natural or artificial). NIRS analysis on carcass traits gave different results: predictions of slaughter weight and fillet yield were fairly good (R^2cv=0.48-0.55), while prediction of the carcass yield was poor (Table 2). Differently, NIRS prediction of the condition factor was successful with a low associated prediction error (R^2cv=0.790, SECV=0.09). The condition factor represents a measure of the fish shape, relating fish weight and length, which changes with the feeding regime and the fish fattening condition.

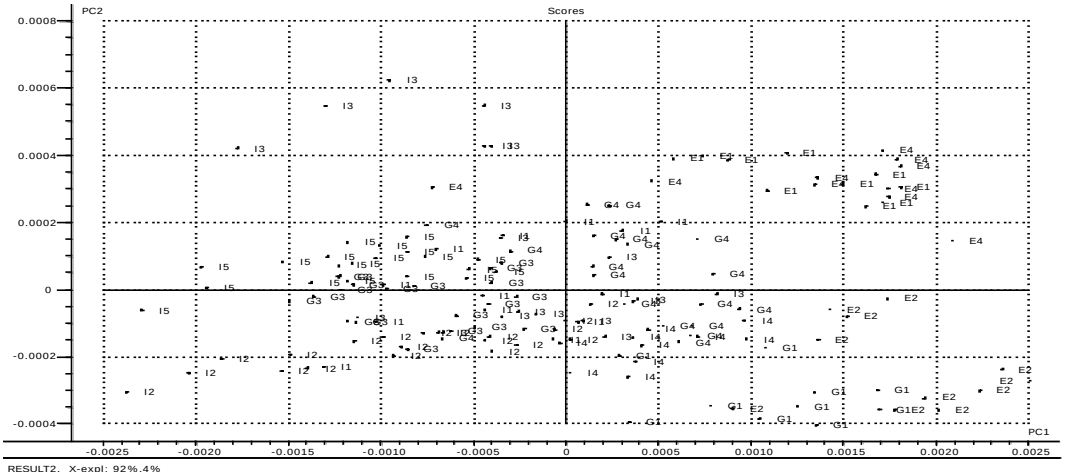
Results of NIRS prediction of chemical composition of freeze-dried fillets showed high correlations (R^2cv>0.90) between NIR spectral information and water, ether extract and energy concentration and high accuracy in NIRS prediction (SECV=0.67%, 0.46% and 0.38 kJ/g for

water, ether extract and energy). Crude protein prediction showed lower, even if still good, performance compared to previous variables (R^2cv=0.734, SECV=0.34). Similar performance in NIRS prediction of fillet chemical composition was obtained by Xiccato *et al*. (2004) in cultivated sea bass.

Using PCA, most of the variability of spectral data was explained by the first PC (92%) (Figure 1). The score plot showed extensively-reared sea bass separated from intensively-reared ones. Within the extensive system, farms were differentiated along the second PC (E1 and E4 separated from E2). Sea cages fish, lying between intensively- and extensively-reared sea bass, were partially confused with these latter: fish of the intensive farm I4 were positioned next to sea bass of the sea-cage G4 and fish from sea-cage G3 were distributed among the intensively-reared sea bass.

Our results confirm NIRS as a useful tool for sea bass characterisation and authentication. Differences in the feeding regimes and commercial slaughter weight among farms of the same rearing system seemed to have a major influence on fish NIR spectra and quality than environmental conditions of farming.

Figure 1. Principal component analysis of NIRS data: score plot (E: fish from extensive lagoons; I: fish from intensive in land-based basins; G: fish from sea cages).



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