LWT - Food Science and Technology 50 (2013) 72–77

Contents lists available at SciVerse ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

# True retention of nutrients upon household cooking of farmed portion-size European sea bass (*Dicentrarchus labrax* L.)

A. Badiani [a,*], S. Stipa [b], F. Bitossi [a], M. Pirini [a], A. Bonaldo [a], P.P. Gatta [a], M. Rotolo [a], S. Testi [c]

[a] Department of Veterinary Medical Sciences, Alma Mater Studiorum – University of Bologna, Via Tolara di Sopra 50, 40064 Ozzano Emilia (BO), Italy
[b] Faculty of Industrial Chemistry, Alma Mater Studiorum – University of Bologna, Viale del Risorgimento 4, 40136 Bologna, Italy
[c] Degree Course in Aquaculture and Hygiene of Fish Productions, Alma Mater Studiorum – University of Bologna, Viale Vespucci 2, 47042 Cesenatico (FC), Italy

ARTICLE INFO

*Article history:*
Received 4 July 2011
Received in revised form
12 January 2012
Accepted 29 June 2012

*Keywords:*
*Dicentrarchus labrax*
True retention
Proximate composition
Fatty acid
Mineral
Water-soluble vitamin

ABSTRACT

Each of ten batches of portion-size farmed European sea bass (overall number = 200, mean weight ± standard error = 312 ± 5 g; total length ± s.e. = 30.5 ± 0.3 cm) was randomly divided into four equally numbered subsamples ($n = 5$). Within batch, one subsample represented the raw reference (RW), while the others were allotted to oven broiling (OB), baking in aluminium foil (BF) or microwaving (MW), selected as mild cooking techniques and therefore among the preferred by Italian fish-eaters. Raw and cooked flesh composition as to proximates, fatty acids, selected minerals and water-soluble vitamins, as derived from OB, BF and MW, were combined with the relevant cooking yields to gain knowledge about the true retention values (TRVs) of these nutrients according to the "reference batch" approach, a well-established method for small-size seafood items as bivalve molluscs and crustaceans. Within the general context of high-yield cooking methods, BF proved to be the mildest, since it left the nutrient profile of sea bass flesh mostly unaffected compared to RW. The reference batch approach generated plausible TRVs for all the nutrients examined, most of which were significantly higher in BF than in OB, with MW data in between.



## 1. Introduction

European sea bass (*Dicentrarchus labrax* L.), one of the most intensively farmed species in Mediterranean countries, has received considerable attention for its macro and micronutrient content, although most published analytical work has been carried out on raw flesh (Fuentes, Fernández-Segovia, Serra, & Barat, 2010; Grigorakis, 2007; Orban et al., 2002; Özden & Erkan, 2008; Yildiz, 2008). In the last few years farmed sea bass flesh has been investigated as to its nutrient content after cooking according to several methods, although on a rather low number of specimens (Küçükgülmez, Çelik, Yanar, Ersoy, & Çikrikçi, 2006; Yanar, Küçükgülmez, Ersoy, & Çelik, 2007).

The usual approach to the study of the effects that cooking may have on nutrient contents of foods consists in highlighting what seems to have been the fate of each chemical component in term of either an increase or a decrease, compared to its content at the raw state. A deeper insight into what cooking could have generated in finfish and shellfish, provided that cooking yields are made available, may be gained from true retention values, or TRVs (Badiani et al., 2006; Dudek et al., 1989; Pirini, Testi, Ventrella, Pagliarani, & Badiani, 2010; Rosa, Bandarra, & Nunes, 2007).

TRVs were first proposed in the mid-1970s (Murphy, Criner, & Gray, 1975) and yet are still in use (USDA, 2010). Indeed, a knowledge of these values has proved useful in allowing a cost-effective updating of food composition tables and databases, all the more profitable for composite foods and nutrients of more complex determination (Reinivuo, Bell, & Ovaskainen, 2009).

TRVs for any nutrient in fish flesh are quite readily and easily attainable as long as large size fish are examined and the "twin fillet" approach adopted (i.e. the use of one fillet as raw control, while its counterpart is cooked), a sound procedure for land-based muscle foods. When only portion-size fish are available, as most often is the case with Mediterranean farmed species, such an approach is no longer feasible in that it requires fillet preparation and cooking, i.e. steps which are both deemed far from being practical for specimens of this size as this would not be representative of how consumers usually prepare them.

Since quite recently the composition of the flesh from farmed sea bass emerged to be fairly homogeneous within source (Roncarati et al., 2010; Pirini and Testi, unpublished results from an

* Corresponding author. Tel.: +39 051 2097380, +39 320 0342628 (mobile); fax: +39 051 2097373.
*E-mail address:* anna.badiani@unibo.it (A. Badiani).
*URL:* http://www.vet.unibo.it/Medicina+Veterinaria/default.htm

0023-6438/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.lwt.2012.06.026

ongoing research project funded by the Italian Ministry of Food, Forestry and Rural Affairs), for this species it would seem sensible to obtain nutrient TRVs by adopting the approach suggested by Murphy et al. (1975) for small size food items. This would require drawing two or more subsamples from a well-mixed batch, one of them serving as the raw control, the other/s being allocated to one (or several) cooking method(s). As a matter of fact, this procedure, defined in the following as the "reference batch" approach, would allow the computation of as many series of nutrient TRVs as cooking techniques of interest (the only limitation being the availability of specimens), which is an obvious advantage compared to the single set of TRVs the twin fillet approach could lead to.

The reference batch approach was implemented and examined in the present study, whose additional goal was to determine the content of selected macro and micronutrients in the flesh of a fairly large number of farmed portion-size European sea bass cooked according to several household methods.

## 2. Materials and methods

### 2.1. Raw material, processing and cooking

Ten freshly caught batches (20 fish each) of 15-to-16-month-old European sea bass (*D. labrax* L.) were received on ice in late Summer through mid Autumn from an intensive commercial fish farm based in Southern Italy. Fish (overall number = 200; overall average weight ± standard error, s.e. = 312 ± 5 g; total length ± s.e. = 30.5 ± 0.3 cm) had been grown in the same conditions, i.e. they had been kept in the same concrete pond and fed the same commercial sea fish feed (45% protein, 25% lipid, 6.5% ash and 1.4% fibre) until the time of sampling.

Within each batch, the whole refrigerated fish were gutted, finned and scaled. Four equally numbered ($n$ = 5 specimens) subsamples of fish were drawn out of each batch, one of which represented the raw reference (RW), whereas the others were randomly allotted to one of the following treatment categories: oven broiling (OB, dry heat), baking in aluminium foil (BF, moist heat), microwaving in a partially covered pan (MW, "combined" heat), which had been selected amongst the plenitude of techniques suggested for this white-fleshed species as being particularly mild and therefore in line with Italian culinary tradition about seafood cooking, which aims at minimising the drying out of the flesh (Slow Food, 2004). In order to respect this tradition and at the same time to produce data to be evaluated in the context of the available scientific information, the decision was taken to avoid the use of salt or any other seasonings during or at the end of cooking, independently of the method used.

In detail, both OB and BF were conducted in a preheated (30 min) forced air convection oven (Model Minimix, Lainox S.r.l., Vittorio Veneto, Italia) set at 180 °C, up to a final internal temperature of 75 °C as ascertained by an iron-constantan (type J) wire thermocouple connected to a digital potentiometer (Mod. Microtemp2, Eurotron Italiana, S.r.l., Sesto S. Giovanni, Italia). Preliminary testing suggested the selection of this final internal temperature, in that it led to a thoroughly coagulated flesh, without any pinkish part left. MW cooking was performed in a 2450 MHz, 1000 W variable power oven (Mod. MT 243/486, Whirlpool Europe, S.r.l., Comerio, Italia) set at 750 W for 9 min in order to reach the same core temperature (75 °C), as checked with a digital thermometer upon removal from the oven. Afterwards, fish, which had been cooked in a Pyrex® pan partially covered with an oxygen-permeable plastic film, were allowed a 20-min standing time. Halfway through every type of cooking, fish were turned upside down to assure uniform heating. For each cooking method, both cooking time (min) and temperature increase (°C) were recorded, to calculate the heating rate as °C/min. After cooking, fish were allowed to drain and cool to room temperature. The final weight was registered to obtain the relevant cooking yield (CY), as the percentage ratio between cooked and raw fish weight.

### 2.2. Proximates, energy value and selected mineral and vitamin contents

After skinning, the separable flesh from each subsample of fish (i.e. treatment within batch) was ground and thoroughly mixed to provide a homogeneous composite paste, the "edible portion", which was analysed in duplicate for moisture, crude protein and ash (methods 950.46B, 981.10 and 920.153, respectively, AOAC, 2000). Total protein was calculated from Kjeldahl nitrogen using a 6.25 conversion factor (Souci, Fachmann, & Kraut, 2008). Lipids were extracted from 10 g of each sample following the method described by Badiani et al. (1996), using chloroform/methanol (2:1, v/v) for extraction. Total lipids (TL) were measured gravimetrically on an aliquot of this extract. Energy value (kJ/100 g edible portion) was derived by multiplying the amount of protein and fat by the rounded conversion factors 17 and 37, respectively (Souci et al., 2008).

Four macro (sodium, Na; potassium, K; magnesium, Mg; calcium, Ca) and two trace elements (iron, Fe; zinc, Zn) were determined using flame atomic absorption spectrometry (FAAS), whereas phosphorus (P) was assayed using UV/VIS spectrometry (Badiani et al., 1996). Total riboflavin, niacin and vitamin $B_6$ were determined by microbiological assay techniques, according to the procedures described by Badiani et al. (1996). During the determination of these vitamins, no attempt was made to separate the various forms under which they are known to be present in seafood (Kim, 2010). It should be emphasised that the selection of this very set of micronutrients was prompted by both budgetary and technical restraints.

### 2.3. Fatty acid analysis

A second aliquot of the fat extract was transferred to a screw cap test tube, stored in a refrigerator (+4 °C) and used within 24 h for fatty acid analysis. Fatty acid methyl esters (FAMEs) from TL were prepared using methanolic sulphuric acid (1:100 v/v), as described by Testi, Bonaldo, Gatta, and Badiani (2006). Chromatographic analyses were carried out with a HRGC 8560 Series Mega 2 (Fisons Instruments, Milano, Italia) fitted with an Omegawax 320 (30 m × 0.32 mm i.d., 0.25 μm film) fused silica capillary column (Supelco, Inc., Bellefonte, PA, USA). High-purity helium was used as the carrier gas at a constant flow of 95 kPa. High-purity hydrogen (50 kPa) and chromatographic air (100 kPa) were supplied to the detector. The injector and detector temperatures were 250 °C and 260 °C, respectively, and the split ratio was 70:1. The oven programming was from 195 °C (6-min hold) to 210 °C at a rate of 5 °C/min, 210 °C (5-min hold) to 230 °C (5-min hold) at a rate of 5 °C/min for a total run time of 23 min. The injection volume was 1 μl.

Methyl esters were identified by comparing the retention time and peak area of the unknowns with those of known FAMEs' standard mixtures (Supelco, Inc.; Alltech Associated, Inc., Deerfield, IL, USA). The fatty acid composition of total lipids was reported as g/100 g oil in the injected sample. The fatty acid quantification within the total lipids, which was necessary in order to determine their TRVs (for computation see Subsection 2.4), was carried out by transforming each of this data to g/100 g edible portion through the lipid conversion factor for finfish as currently used by the United States Department of Agriculture to prepare and update its Nutrient Database (USDA, 2010). In addition, a Peroxidisability Index (PI) was computed according to Erickson (1992), to take into account