SENSORY AND PHYSICO-CHEMICAL TRAITS IN WILD AND CULTURED EUROPEAN SEA BASS (*Dicentrarchus labrax*)

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Abstract – The aim of this study was to search chemical and fatty acid composition, instrumentally measured colour and texture parameters of the meat, as well as the sensory quality of wild and cultured European sea bass. The main differences in basic chemical composition were in significantly higher fat and, consequently, lower water content of cultured fish in comparison with wild ones. While cultured sea bass express better flavour and overall impression, no significant differences were found in sensorially evaluated colour of raw and thermally treated meat, smell, texture, mouth feeling and fatness. No statistically significant differences were found in instrumentally measured and sensory evaluated texture of meat. Instrumentally measured colour showed significantly redder colour (higher a* value) of wild sea bass then of cultured ones. While the fats in wild sea bass contained a higher portion of palmitic (22.7 wt. %), cultured ones contained a higher portion of oleic acid (22.9 wt. %). Lipids in cultured sea bass contained a higher portion of PUFA and MUFA, better P/S ratio (1.52 *vs.* 0.81) and better atherogenic index (0.39 *vs.* 0.52) then in wild ones. Contrary, the fats in wild sea bass had higher shares of SFA, *n*-3 PUFA, *n*-3 LC-PUFA and better *n*-6/n-3 ratio (0.32 *vs.* 1.05) than in cultured ones. Considering more than two times higher lipids (fat) content in cultured sea bass, the cultured sea bass contribution to health protection is more effective than with wild ones.

Key Words – chemical composition, fatty acids, sensory analyses.

I. INTRODUCTION

There is a variety of food to choose from on the market nowadays, which also applies to fish. They can be cultured in fish farms or caught in their natural habitat. Although there are several reasons arguing the higher price of wild fish compared to cultured ones, the question that arises is, whether the price difference is justified by the difference in the quality of fish meat of both groups. For the studied fish species we took sea bass (*Dicentrarchus labrax*) and compared the quality of wild and cultured fish of similar size or weight. The main hypothesis was that the majority of parameters give better results for wild sea bass.

II. MATERIALS AND METHODS

A total of 14 sea bass caught in the southern Mediterranean were included in the study, a group of cultivated (7) and a group of wild (7). Wild fish were caught in the Levantine Sea in Egypt (FAO fishing area 37.3.2) and cultured in the Aegean Sea in Greece (FAO fishing area 37.3.1). The sample represented the edible part of the fish (fillet) and was kept in the freezer until analysis.

Water, protein, fat and ash content were determined by the methods described in AOAC [1]. The fatty acid composition of samples was determined by the method *in situ* transesterification modified after Park and Goins [2] and by GC.

To evaluate the sensory quality, a panel of four qualified and experienced panellists in the field of fish was appointed. An analytical-descriptive test was performed by scoring the sensory attributes according to a non-structured scale from 1 to 7 points, where a higher score indicated greater expression of a given property. An exception here was for the texture, which was evaluated by scoring on a structured scale of 1 to 4 to 7 (1-4-7). Here, a score of 4 points was considered optimal, with scores of 4.5 or more indicated greater (to excess) expression of a property (firmer), and those of 3.5 or less indicated lesser (insufficient) expression of a property (tenderer texture). The colour was assessed on uncooked fillets, while the other parameters were assessed on baked fillets (T_s = 80 °C, T_{oven} = 200 °C).

Four instrumental measurements of CIE $L^*a^*b^*$ values were made on raw sea bass fillet surface. A Minolta CR 200b colorimeter (Illuminant C, 0° viewing angle) was used to determine the CIE L^* (lightness), a^* (+/-, red to green), and b^* (+/-, yellow to blue) values. A white ceramic tile with the specification of Y = 93.8, x = 0.3134, and y = 0.3208 was used to standardise the colorimeter.

Shear force was measured six times using a TA.TX plus texture analyser (Stable Micro Systems) and expressed in N. The crosshead speed was 2×10^{-3} m/s, filet width 62 mm, thickness 20 mm and temperature of 9-10 °C.

The data were analyzed by the analysis variance (ANOVA; R Development Core Team, 2011). The statistical model for data acquired by physico-chemical and sensory analyses of fish meat included the effects of group (G_i; i = wild, cultured) and repetition within the group (M_j; j = 1-7): $y_{ijk} = \mu + G_i + M_j + e_{ijk}$.

III. RESULTS AND DISCUSSION

Table 1. Physico-chemical and sensory traits in wild and cultured European seabass (*Dicentrarchus labrax*)

Parameter	cultured	wild	s.
Chemical composition (g/100 g)[a]			
Water	68.7±3.2[b]	73.7±1.5[a]	**
Protein	20.3±1.2	21.2±1.1	ns
Fat	11.0±4.6[a]	5.2±2.2[b]	**
Ash	1.23±0.06	1.18±0.07	ns
Sensory trait (points)			
Colour, raw (1-7)	4.75±0.44	4.59±1.04	ns
Colour (1-7)	5.7±0.37	5.52±0.54	ns
Smell (1-7)	5.68±0.31	5.71±0.35	ns
Texture (1-4-7)	3.29±0.37	3.37±0.42	ns
Mouth feeling (1-7)	5.3±0.31	5.21±0.5	ns
Fatness (1-7)	2.23±0.35	2.11±0.31	ns
Flavour (1-7)	5.86±0.33[a]	5.52±0.32[b]	**
Overall impression (1-7)	5.71±0.32[a]	5.41±0.33[b]	**
Instrumentally measured colour			
L^* value	54.9±2.1	55.4±4.3	ns
a^* value	-0.6±1.2[a]	1.3±1.9[b]	*
b^* value	2.0±3.1	1.0±2.0	ns
Instrumentally measured texture			
Share force (N)	38.7±15.8	35.1±13.7	ns

[a] raw meat, s., levels of significance: statistically significant $^*P \le 0.05$ and $^{**}P \le 0.01$; highly statistically significant: $^{***}P \le 0.001$; statistically not significant: ns – $P > 0.05$; means with a different superscript within rows (a, b) differ significantly ($P \le 0.05$)

Table 2. Fatty acids composition of wild and cultured European seabass (*Dicentrarchus labrax*)

Fatty acid (wt. %/total FA)	cultured	wild	s.
C8:0	0.10±0.08	0.13±0.08	ns
C12:0	0.03±0.00[b]	0.07±0.00[a]	***
C13:0	0.01±0.00[b]	0.03±0.00[a]	*
C 14:0	3.46±0.05	3.07±0.05	ns
C 14:1 *t*-7	0.11±0.00[b]	0.26±0.00[a]	***
C 14:1 *c*-7	0.06±0.00[b]	0.14±0.00[a]	***
C15:0	0.27±0.01[b]	0.64±0.01[a]	***
C 15:1 *c*-5	0.08±0.01[b]	0.16±0.01[a]	***
C15:1 *c*-10	0.04±0.00[b]	0.12±0.00[a]	**
C 16:0	14.94±0.10[b]	20.70±0.10[a]	***
C 16:1 *t*-9	0.37±0.01[b]	0.82±0.01[a]	***
C 16:1 *c*-9	4.58±0.04[b]	7.47±0.04[a]	***
C 17:0	0.46±0.00[b]	0.88±0.00[a]	***
C17:1 *t*-10	0.25±0.01[b]	0.34±0.01[a]	*
C17:1 *c*-10	0.19±0.03[b]	0.67±0.03[a]	**
C18:0	3.17±0.05[b]	5.15±0.05[a]	***
C18:1 *c*-7	0.39±0.02[b]	0.73±0.02[a]	***
C18:1 *t*-9	0.07±0.00[b]	0.25±0.00[a]	***
C 18:1 *c*-9	22.94±0.25[b]	17.83±0.25[a]	***
C 18:1 *c*-11	0.23±0.07[b]	5.21±0.07[a]	***
C 18:2 *tt*-9,12	0.33±0.00[b]	0.15±0.00[a]	***
C 18:2 *tc*-9,12	0.20±0.00	0.23±0.00	ns
C 18:2 *ct*-9,12	0.09±0.00[b]	0.20±0.00[a]	**
C 18:2 *cc*-9,12	15.99±0.02[b]	3.56±0.02[a]	***
C 18:3 *ccc*-6,9,12	0.14±0.00	0.29±0.00	ns
C 18:3 *ccc*-9,12,15	0.15±0.01[b]	0.22±0.01[a]	***
C 20:0	0.09±0.01[b]	1.08±0.01[a]	**
C 20:1 *c*-8	2.09±0.01[b]	0.27±0.01[a]	***
C 20:1 *c*-11	3.92±0.01[b]	1.12±0.01[a]	***
C 18:4 *n*-3	0.82±0.01[b]	0.41±0.01[a]	***
C20:2 *cc-5,14*	0.17±0.00[b]	0.49±0.00[a]	*
C20:2 *cc-11,14*	0.74±0.01[b]	0.17±0.01[a]	***
C20:3 *n*-6	0.06±0.01	0.24±0.01	ns
C22:0	0.11±0.13[b]	0.25±0.13[a]	*
C20:3 *n*-3 + C20:4 *n*-6	0.56±0.03[b]	2.91±0.03[a]	***
C22:1 *c*-13	2.82±0.01[b]	0.16±0.01[a]	***
C22:2 *cc*-13,16	0.58±0.01	0.67±0.01	ns
C20:5 *n*-3	6.91±0.07	6.62±0.07	ns
C24:0	0.04±0.00[b]	0.13±0.00[a]	***
C24:1	0.29±0.01[b]	1.01±0.01[a]	***
C22:5 *n*-3	1.65±0.02[b]	2.86±0.02[a]	*
C22:6 *n*-3	8.85±0.14	10.21±0.14	ns

s., levels of significance: statistically significant $^*P \le 0.05$ and $^{**}P \le 0.01$; highly statistically significant: $^{***}P \le 0.001$; statistically not significant: ns – $P > 0.05$; means with a different superscript within rows (a, b) differ significantly ($P \le 0.05$)

Both groups of sea bass, wild and cultured, had statistically comparable weight; the average mass of a wild sea bass was 1450 g and 1246 g of a cultured one. Cultured sea bass meat contained significantly less water (5%) and more fat (5.8%) than wild ($P \leq 0.01$), while the total protein and ash content did not vary. More fat in farmed sea bass can be attributed to abundant food and limited movement. Basic chemical composition was similar to the one in literature sources (Alasalvar et al. [3]; Orban et al. [4]; Fuentes et al. [5]).

Cultured fish obtained greater sensory appreciation results (significantly better flavour and overall impression) in comparison with wild ones. Instrumental colour measurement of fresh muscle tissue has shown significantly ($P \leq 0.01$) redder (higher a* value) meat of wild than cultured sea bass. Fuentes et al. [5] have found comparable a* and b* values as in our study. Redder colour of wild fish is probably due to increased levels of myoglobin – fish that are moving more, contain a higher level of myoglobin (Carpene et al. [6]). But it can also present some other colourings; the wild fish can obtain those with diet. There was no difference in texture between groups. Slightly firmer texture of cultured sea bass compared to the wild is not consistent with findings of Fuentes et al. [5].

The most commonly presented fatty acids (FA) in fat from sea bass are oleic (C18:1*c*-9), palmitic (C16:0), linoleic (C18:2*cc*-9,12), docosahexaenoic (DHA, C22:6*n*-3), and eicosapentaenoic (EPA, C20:5*n*-3). Differences in their share (wt. % of total FA) between wild and cultured see bass were statistically significant ($P \leq 0.001$), with the exception of EPA and DHA. Together, EPA and DHA, the nutritionally most important FAs, presented a 2-fold higher share in cultured fish than in wild ones and content exceeding 1.5 g per 100 g of fish meat, which exceeds the value necessary to protect against cardiovascular disease (Nesheim & Yaktine [6], Galli et al. [7]). In this regard, farmed sea bass show better nutritional quality of lipids than wild ones. Generally, the level of DHA is greater than the level of EPA. Cultured sea bass contained more polyunsaturated fatty acid (PUFA), mainly due to large amounts of *n*-6 PUFA. Wild fish contain higher content of health useful *n*-3 PUFA and also a 10% higher content of harmful saturated fatty acid (SFA) than cultured ones. If we look at the amount of *n*-3 long chain polyunsaturated fatty acids (*n*-3 LC PUFA) (mg/100 g meat) the wild fish contained twice as many *n*-3 LC PUFA than cultured ones. Differences in the fatty acid composition of both groups of bass can be attributed to different diets. Results of our study, indicating that wild sea bass contained the highest amount of palmitic acid, are consistent with the literature (Alasalvar et al. [9]; Fuentes et al. [5]). In this group, perhaps surprisingly, the content of DHA is quite low (below average) and the content of palmitoleic acid is high. The highest content of oleic acid in cultured sea bass has been shown in almost all previous research (Alasalvar et al. [9]; Sağglik et al. [10]; Periago et al. [11]; Bell et al. [12]; Erdem et al. [13]; Fuentes et al. [5]).

Both groups have highly favourable P/S index (0.81 *vs.* 1.52), but this index is higher (better) in cultured sea bass, which also have a better (lower) index of atherogenicity – IA (0.39 *vs.* 0.52). Fat of wild sea bass has almost three times better ratio of *n*-6 and *n*-3 PUFA (0.32 *vs.* 1.05), which reduces the risk of thrombosis and atherosclerosis in human.

Table 3. Calculated nutritional information of European seebass fat

Parameter	cultured	wild
SFA	22.68	32.14
MUFA	38.44	36.56
PUFA	35.00	26.95
n-3 PUFA	16.14	18.04
n-6 PUFA	16.98	5.16
LC- PUFA	18.11	22.29
n-6 LC-PUFA	0.24	0.72
n-3 LC-PUFA	15.99	17.82
n-6/*n*-3 PUFA	1.05	0.32
n-6/*n*-3 LC-PUFA	0.02	0.05
P/S	1.52	0.81
IA	0.39	0.52
EPA/DHA	0.78	0.62

IV. CONCLUSION

Since the sensory quality of the cultured sea bass meat has been evaluated higher and also by instrumental texture analysis than of wild sea bass, the hypothesis of this study was only partially confirmed. Anticipation that the wild sea bass are more lean than cultured has been confirmed, however, the nutritional aspect of fatty acid composition of cultured fish is better.

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