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# Comparison of Biochemical Composition and Organoleptic Properties Between Wild and Cultured Finfish

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**Abstract:** The aim of this study was to determine whether there are organoleptic differences among wild and cultured finfish (tilapia, mullet, sea bream, mulloway) and to find their possible chemical basis. Wild and pond-cultured fish of the same average weight were compared. The results showed a strong organoleptic difference between wild and cultured fish. The tests also showed a preference on wild fish, while most common descriptors given for wild fish were more pleasant taste, more firm texture and for cultured fish were poorer taste. From these answers, a superiority of wild fish is strongly indicated. Organoleptic differences can be related to proximate analysis. The results of heavy metal analysis showed that the commercial fish farming had a higher level of chemical contamination in their aquatic environment and their production of finfish than in the open water.

**Key words:** Organoleptic properties, proximate analysis, heavy metals, wild, cultured, tilapia, mullet, sea bream, mulloway

## INTRODUCTION

The difficulty to define nature of diet and environmental history of free living fish makes contrast of sensory attributed of wild and cultured fish difficult. This can be confirmed by the fact that the consumers' preference on farmed or wild salmon may vary dramatically with time or geographic location where wild salmon is harvested (Haard, 1992). However, existing literature clearly indicates that significant organoleptic differences always occur when comparison wild and cultured counterparts of the same species. Many studies in various species, such as Chinook salmon (Sylvia *et al*., 1995), Australian snapper (Prescott and Bell, 1992) and channel catfish (Webster *et al*., 1993) confirm this. In general, the meat of farmed fish tends to be softer in texture and has a milder less robust flavor than wild fish. Also, color of the flesh and general appearance of skin and flesh differ significantly between wild and cultured fish in many cases (Mohr, 1986; Karahadian and Fowler, 1991).

Protein, oil, moisture and ash contents (proximate composition), are traditionally used as indicators of the nutritional value of fish (Stansby, 1962). Although a quite voluminous literature on the proximate composition of the world's food fish exists (Sidewell *et al*., 1974), there is a lack in literatures on the organoleptic differences of wild and cultured finfish in Egypt. The aim of this study was to organoleptically compare wild and most important cultured fish in Egypt (tilapia, mullet, sea bream, mulloway). Furthermore, we made an attempt to correlate these differences to their proximate compositions. Also heavy metal contents of tested wild fish and cultured counterparts were compared.

## MATERIALS AND METHODS

The fish, which was tested, include two brackish water species, the tilapia (*Oreochromis niloticus*) and the mullet (*Mugil cephalus*) and two marine species, the sea bream

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(*Sparus aurata*) and the mulloway (*Argyrosomus regius)* which are the main products of aquaculture in Egypt. Fish of commercial size the only one was used. The wild fish was collected from the retail fish market and the same average weight of the cultured counterparts was collected from selected farms. All the samples were kept frozen until needed for analysis.

Three replicate samples of each species were weighed and oven-dried until constant weight was recorded. Moisture, crude fat, protein and ash contents of each triplicate sample were determined by the standard methods as reported in AOAC (1984). Total carbohydrates were calculated by difference.

Organoleptic evaluation of cooked fish was performed by aid of ten panelists according to Klein and Bardy (1984). The tested, cocked fish were evaluated according to their aroma (freshness), color, texture, taste and the acceptability of it. The fresher, whiter, firmer, juicier and more acceptable the fish was, the higher the score given. The score was given from 1 to 10 as the following: 9-8 very good; 7-6 good; 5-4 fair; 3-1 poor.

For analysis of heavy metals, also three replicate samples of each species were taken. The trace metals (Fe, Mn, Zn, Cu, Co and Pb) were determined according to APHA (1995). The obtained elements were detected by using Perkin Elmer 2380 Atomic Absorption Spectrophotometer. Values were expressed as mg $kg^{-1}$.

## RESULTS

Muscle proximate compositions of cultured and wild finfish are presented in Table 1. In almost all cases, wild fish were found to have lower water (69.19-74.24%), lipid (1.12-8.93%) and carbohydrates contents (2.55-5.23%) in their muscles than in cultured counterparts (68.25-79.53, 1.41-9.41, 2.57-8.54%, respectively). On the contrary, the percentages of protein (14.08-20.44%) and ash contents (1.63-2.61) were higher in wild than in cultured fish (13.66-17.76, 1.56-2.16%, respectively).

The results of the organoleptic test for the differences between cultured and wild fish after cocking are illustrated in Table 2. The panelists were clearly able to distinguish the differences in color, texture and taste between cultured and wild fish. Meanwhile, they were not able to differentiate the differences in aroma. The general trend was the preferences for all the wild fish. Wild mulloway had the highest overall preference; wild sea bream had the next highest preference followed by mullet and tilapia.

Table 1: Chemical composition of different cultured and wild finfish (mean±SE)

| Species | | Moisture | Fat | Protein | Carbohydrate | Ash |
|---|---|---|---|---|---|---|
| Tilapia | Cultured | 79.53±0.34 | 1.41±0.01 | 13.66±0.11 | 3.27±0.16 | 2.13±0.03 |
| | Wild | 78.00±0.34 | 1.12±0.03 | 15.26±0.20 | 3.01±0.19 | 2.61±0.07 |
| Mullet | Cultured | 70.23±0.21 | 9.41±0.08 | 14.08±0.13 | 4.55±0.10 | 1.73±0.01 |
| | Wild | 69.19±0.19 | 8.93±0.10 | 16.12±0.09 | 3.93±0.11 | 1.83±0.03 |
| Sea bream | Cultured | 68.25±0.31 | 3.89±0.08 | 17.76±0.16 | 8.54±0.09 | 1.56±0.03 |
| | Wild | 69.21±0.25 | 3.49±0.11 | 20.44±0.21 | 5.23±0.10 | 1.63±0.01 |
| Mulloway | Cultured | 76.21±0.39 | 4.56±0.02 | 14.50±0.31 | 2.57±0.12 | 2.16±0.06 |
| | Wild | 74.24±0.17 | 3.88±0.01 | 17.10±0.11 | 2.55±0.08 | 2.23±0.06 |

Table 2: Organoleptic properties of grilled cultured and wild tested finfish

| Species | | Aroma (10) | Color (10) | Texture (10) | Taste (10) | Acceptability (10) | Total acceptability (50) |
|---|---|---|---|---|---|---|---|
| Tilapia | Cultured | $8^{d}$ | $8^{d}$ | $5^{a}$ | $7^{c}$ | $5^{a}$ | 30 |
| | Wild | $9^{e}$ | $7^{c}$ | $8^{d}$ | $8^{d}$ | $8^{d}$ | 39 |
| Mullet | Cultured | $8^{d}$ | $8^{d}$ | $6^{b}$ | $7^{c}$ | $5^{a}$ | 31 |
| | Wild | $8^{d}$ | $6^{b}$ | $9^{e}$ | $9^{e}$ | $9^{e}$ | 41 |
| Seabream | Cultured | $9^{e}$ | $9^{e}$ | $7^{c}$ | $7^{c}$ | $7^{c}$ | 36 |
| | Wild | $9^{e}$ | $6^{b}$ | $9^{e}$ | $8^{d}$ | $9^{e}$ | 41 |
| Mulloway | Cultured | $9^{e}$ | $9^{e}$ | $7^{c}$ | $7^{c}$ | $7^{c}$ | 36 |
| | Wild | $9^{e}$ | $7^{c}$ | $9^{e}$ | $9^{e}$ | $9^{e}$ | 43 |

* Means in the same column for the same species (cultured/wiled) with different superscripts are significantly different at $p<0.05$

Table 3: Heavy metals concentrations in the wild and cultured studied species (Values are expressed as mg $kg^{-1}$)

| Species | | Fe | Mn | Zn | Cu | Co | Pb |
|---|---|---|---|---|---|---|---|
| Tilapia | Cultured | 36.95 | 3.95 | 22.00 | 4.99 | 11.3 | 2.41 |
| | Wild | 27.28 | 1.90 | 13.94 | 2.67 | 8.24 | 2.32 |
| Mullet | Cultured | 28.03 | 2.18 | 18.30 | 2.69 | 7.23 | 1.80 |
| | Wild | 23.98 | 2.13 | 10.00 | 2.21 | 6.15 | 0.99 |
| Sea bream | Cultured | 25.94 | 2.14 | 14.60 | 2.43 | 7.16 | 2.10 |
| | Wild | 23.30 | 1.35 | 11.58 | 1.88 | 6.09 | 0.26 |
| Mulloway | Cultured | 22.09 | 1.75 | 8.94 | 2.19 | 6.82 | 0.78 |
| | Wild | 20.02 | 1.73 | 7.94 | 2.06 | 5.27 | 0.78 |

Table 3 shows the average concentrations of heavy metals in the wild and cultured finfish. The results indicated that there is a variation in the heavy metal content among the four studied species and between the cultured and wild species. Generally, the heavy metal content in the wild species is less than its content in cultured one. The highest mean concentration of heavy metals was recorded in tilapia and mullet, while the lowest mean concentration was recorded in sea bream and mulloway.

## DISCUSSION

Wild and cultured fish were found to differ significantly in their organoleptic properties and also in their muscle proximate compositions. Heavy metals content of wild and cultured fish differed as well. Organoleptic differences can be related to a high degree to the compositional differences.

The present study indicates that there was no difference between the aroma of cultured and wild fish, most of the assessors were not be able to differentiate between them. While, the cultured fish were found to have a more white appearance of its muscle compared to the wild counterparts. The impression of fillets originated from wild fish looking darker might be related to the higher proportion of dark muscle in them. The dark muscles are used for continuous swimming motion, while white muscles help rapid energy bursts (Venugopal and Shahidi, 1996). In addition, the higher fat content in cultured fish may contribute to its whiter appearance. The present study agrees with the results of Grigorakis *et al*. (2003) on organoleptic comparison of wild and cultured gilthead sea bream.

The proximate composition can affect the sensory textural properties of the fish, as differences in texture of fish muscle tissue have been related to the lipid, protein and water contents (Venugopal and Shahidi, 1996). With reference to the textural impression, in the present study, wild fish were found to have a firmer flesh. This can be explained by the lower muscle fat content. Dunajki (1979) found that water and lipid contents resulted to softer texture when they were related to the higher muscle protein content of the wild fish, which may mirror a different muscle structure. Thus, Hatae *et al*. (1990) have stated that the species with less water, plus higher protein content became firmer when cooked. However, protein content by itself does not give much information on the fish muscle texture, as other protein factors such as collagen content and structure and muscle fiber diameter (Venugopal and Shahidi, 1996; Rasmussen, 2001).

Concerning the taste, it seems that the higher fat content in cultured fish affect taste giving them the characterization of more juicy. In a study on salmon, Einen and Thomassen (1998) have shown a very strong correlation of sensory fatness and juiciness to the fillet fat content. Although fats have been proposed to modify tenderness, bite, lubrication elasticity and juiciness, the precise mechanism of action of lipids is very difficult to define (German, 1990). It was previously found (Orban *et al*., 1996, 1997; Grigorakis *et al*., 2003) that the same cultured and wild sea bream used for the taste panel in the present study differed significantly in their color, texture and taste.

Results of the present study generally agree with existing literature, where in comparisons wild fish appear to be, almost always, superior to cultured fish. In a study on organoleptic qualities of different salmon types, wild chinook salmon was found to have higher sensory qualities than the cultured counterpart and the cultured Atlantic salmon (Sylvia *et al*., 1995). Also other organoleptic

comparisons on channel catfish (Webster *et al*., 1993), hybrid striped bass (Postel *et al*., 1996) and Australian snapper (Prescott and Bell, 1992) also indicated differences among cultured and wild fish with organoleptic superiority of the latter. However, another study (Farmer *et al*., 2000) correlated sensory characteristics and overall acceptability of Atlantic salmon to the water body origin, rather to whether it was farmed or wild.

On the other hand, the safety of the studied fish was determined by analyses of their heavy metal contents. Food contamination monitoring is an essential component of assuring the safety of food supplies and managing health risks at the international level. The present study indicated that the pattern of environmental pollution is obviously remarked in finfish supplied by fish farming since the highest heavy metal contents were recorded in cultured fish. The present data suggested that, among the studied fish, tilapia and mullet are most vulnerable to metal pollution. They could be more vulnerable because they are exposed to metals from sediments, in which they feed. Accumulation of trace metals in aquatic organisms has been correlated to their feeding habits (Langston and Spence, 1995). Eissa *et al*. (2002) concluded that the high concentration of heavy metal in muscles of mullet might be attributed to their feeding behavior as they considered bottom feeders fish.

In conclusion, wild fish seemed to be more acceptable and healthy than cultured fish. This preference was expressed mainly in relation to the taste and texture attributes, as derived from the descriptors given, with a significant number of assessors characterizing the wild fish with attributes such as more pleasant taste, or more delicious and the cultured fish as having a poorer taste. Meanwhile, health authorities have not yet approved the use of effluent for fish farming in Egypt. Thus, general effort should be spend for standardizing the quality of every product that is being used within the Egyptian market specially the quality is an important aspect in international trade.

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