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Study of elements concentrations of European seabass (*Dicentrarchus labrax*) fillets after cooking on steel, cast iron, teflon, aluminum and ceramic pots

Giovanna Lomolino*, Antonella Crapisi, Massimo Cagnin

Department of Agronomy, Food, Natural Resources, Animals, and Environment – DAFNAE Università degli Studi di Padova, Agripolis, Viale dell'Università, 35020 Legnaro, Padova, Italy

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Abstract

Some elements and metals (Al, Ca, Cr, Cu, Fe, Mn, Ni, Pb, Se, Sr, Zn, P) were analyzed in European seabass (*Dicentrarchus labrax*), by comparing the concentration in raw and in the cooked fish. In particular, the cooking of European seabass was carried out on pots made of five different materials (cast iron, aluminum, steel, teflon and ceramic), commonly used in gastronomy.

By measuring mineral elements and metals content of the fish before and after cooking on the 5 materials, there is an increase in elements which is due not only to water loss but also by the release of the materials upon contact with the surface of the pots. Among the analyzed elements the exception is represented by Cr, Se and Fe which decrease with cooking, while Pb remains unvaried.

The use of 2 model solutions, made of water and water and vinegar, demonstrates that the used cooking materials are not inert to the leaching/release of elements that could be found in the processed fish.

Keywords: Seabass; Seafood; Inductively coupled plasma optical emission spectrometry (ICP-OES); Metals; Cooking materials

Introduction

In the last decades, due to the improvement of living standards and increased knowledge of the beneficial effects associated with the consumption of seafood, the global demand for fish has grown to reach 145.1 million tons in 2009 (He et al., 2010; FAO, 2010; FAO/WHO, 2011). Fish has always had an important place in human nutrition and it was a desirable foodstuff not only because of its gastronomic characteristics but also because of high nutritional value. Fish consumption is widespread in many parts of the world, is a very important component in the Mediterranean diet, and it has been demonstrated that its consumption is associated with a significant reduction in mortality (Trichopoulou et al., 2003).

European seabass (*Dicentrarchus labrax*) is considered one of the most appreciated species of Mediterranean area and, fished or aquacultured, is important not only for local consumption but also for exportation. The fish presents a white flesh, mild taste and low fat content (Erkan and Özden, 2007).

Seafood in general, and European seabass, are important for nutritional reasons due to the high content of animal protein, the low concentration of saturated fat and the presence of ω3 fatty acids, vitamins and phospholipids (U.S. EPA, 2004). However, in recent years, the assessment of risks and benefits of fish consumption has been particularly controversial (Guérin et al., 2011). Nutritionists consider the seafood as a source of mineral elements, essential for health, and toxicologists tend to view seafood as an array

*Corresponding author. Fax: +39 049 8272929.
E-mail address: Giovanna.lomolino@unipd.it (G. Lomolino).
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of toxic substances such as metal traces and organic pollutants. In fact, many compounds found in fish, are essential or toxic for human life when they are present at low or high concentrations, respectively. For example, chromium and nickel are essential trace elements (Canli and Kargin, 1995) while heavy metals, such as cadmium, cobalt and lead, are toxic even when present in traces. Many metals and metal compounds in the marine environment pose a risk to human health because the concentration of the contaminants, the exposure and bioaccumulation make metals dangerous health hazards for organisms (Djedjibegovic et al., 2012). Metals in the water can be of natural origin from the rocks or soil, or by human activities, including industrial, domestic wastewater, agricultural run-off, etc. (U.S. EPA, 2000). Fish can contribute significantly to human dietary exposure to environmental pollutants (Guérin et al., 2007) and, in many studies, the fish have been used as bio-indicators of environmental contamination (Kasper et al., 2007). However, factors such as the weather, the place of fishing, habitat, gender and age can change the chemical constituents and pollutant burden may vary between species and even between individuals of the same species (Maia et al. 1999). Even cooking can affect the concentration of elements in fish (Ersoy et al., 2006; Kalogeropoulos et al., 2012; He et al., 2010; Atta et al., 1997). Some authors have studied the effect of different methods of fish cooking (grilled, baked, microwaved, fried etc.) on the final concentration of the elements in the cooked product. In fact, the water loss of the product during cooking can increase or deplete the element content in the fish (Atta et al., 1997; Kalogeropoulos et al., 2012). Moreover, also the release/leaching of elements and metals from the cooking materials can affect their final concentration in seafood. Several studies have been conducted on the release/leaching of metals from cooking materials made of ceramic (Mohamed et al., 1995) aluminum (Veríssimo et al., 2006) and iron (Adish et al., 1999) and the effect of the composition and pH of the food in the release of these metals. Regardless of the type of food that is being cooked, the recipe and the way of preparing the food must play an important role on the elements release/leaching levels. The interaction between food and cooking materials can be a potential source of release of metals that can be ingested.

In this research, we studied the concentration of metals and elements in European seabass after grilling on 5 cooking materials: cast iron, aluminum, steel, teflon and ceramic, commonly used in gastronomy, compared with those determined on the raw European seabass. Furthermore, in order to simulate the effect of cooking in the release/leaching of metals and elements from the 5 cooking materials, we used 2 model solutions, boiled for few minutes. The cooking materials on the market vary in function of alloys and brands and this affects the release level of elements during cooking. Although this research is limited to a single brand, it presents an approach to the study of elements release from the most common cooking materials that may come into contact with food.

The results were compared with data and results of the scientific international literature.

Materials and methods

Samples

30 fish (seabass), *D. labrax*, used in this study, were obtained from a seabass farm, in Greece. The considered fish weight was 900–1000 g, in order to limit variations and operate in the same weight conditions.

The fish was gutted, filleted and grilled within 24 h of arrival to preserve any characteristic. The fillet samples were of 100 g, obtained by eliminating any bony, belly and skin part, as they are rich in fats.

Cooking

To grill the fish, 5 pots of different materials were used: aluminum, steel, cast iron, and non-stick coatings such as teflon and ceramic. The pots were of the same size and shape. The pots used were of frying pan model with 24 cm diameter (Ballarini brand); for the experiments 3 frying pans of each material were considered.

The cooking was carried out without any dressing, in a dry condition, highlighting and enhancing the differences that emerge by the use of any type of cooking material. For each cooking test on the different materials, 3 fillet of 100 g each, were considered and then processed for ICP analysis.

To carry out the test under the same thermal conditions, the temperature of the pot surfaces were measured before placing the fish fillets. The monitored temperature was considered adequate when reached 110 °C; pot surfaces at high temperature allows to cook the fillets without sticking them to the pot surfaces. Furthermore, to avoid inhomogeneities of the samples and ensure an optimal cooking, the fish fillets were considered cooked when the temperature reached 65 °C at the heart of the product. Although in other gastronomical cultures, higher temperatures (80° C) or lower (45° C) at the heart of the product are considered optimal, in this context 65° C was chosen as an operational choice that reproduce an intermediate situation. To understand the difference in conductivity of each material, the time required to reach 65 °C at the heart of the product was measured. Since the pot were hot on the moment of the fillet contact, fish fillet did not stick on the pot surface. To study the effect of cooking on the water loss of the seabass, the weight of the fillet was taken before and after grilling on the 5 materials.

The fish fillet parts in contact with the surfaces of cooking materials were considered for the following analyses (see below).

In order to study the release of the minerals from the cooking materials, 500 mL of MilliQ water and 500 mL of a solution containing 10% (v/v) of commercial white wine vinegar with 6% (v/v) of acetic acid, pH 3.1 were kept boiling for 3 min. After boiling solutions, no volume change was observed.