Nutritional quality and safety of European perch (*Perca fluviatilis*) from three lakes of Central Italy

Elena Orban [a,*], Teresina Nevigato [a], Maurizio Masci [a], Gabriella Di Lena [a], Irene Casini [a], Roberto Caproni [a], Loretta Gambelli [a], Paola De Angelis [b], Massimo Rampacci [b]

[a] *National Research Institute for Food and Nutrition, Seafood Study Unit, Via Ardeatina 546, 00178 Rome, Italy*
[b] *A.Ge.I. Agricoltura Gestione Ittica S.c. r. l. Via Carlo Emanuele I, 11 – 00185 Rome, Italy*

Abstract

European perch (*Perca fluviatilis*) harvested from three lakes of Central Italy were studied in different seasonal periods of a year to evaluate their nutritional quality and some safety aspects related to the pollution of the aquatic environment. The lakes considered, located in the Latium region, differed with respect to their volcanic (Bolsena and Bracciano Lakes) or artificial (Salto Lake) origin. Fillets of fish caught in the three lakes were characterised by good protein (17–19%) and mineral contents and low lipid levels (0.6–1.2%) throughout the year. Total lipids were characterised by low cholesterol levels (41.9–74.7 mg/100 g) and high percentages of total $n - 3$ polyunsaturated fatty acids (27.7–33.8% of total fatty acids), in particular docosahexaenoic acid (14.2–25.3% of total fatty acids). The qualitative analysis of the stomach content of perch confirmed their predatory feeding behaviour. The chemical and nutritional profiles of perch from the three lakes were comparable except for rubidium and cesium levels, which were higher in the muscle tissues of perch from the volcanic lakes. These minerals may represent elements of traceability of the origin of fish. Low levels of organochlorine pesticides and polychlorinated biphenyls, well below the Italian and European action limits, were detected in the muscle tissue of perch from all three lakes.
© 2005 Elsevier Ltd. All rights reserved.

Keywords: Freshwater fish; Perch; *Perca fluviatilis*; Nutritional quality; Safety; Organochlorine pesticides; Polychlorinated biphenyls; Traceability

1. Introduction

The European perch (*Perca fluviatilis* L.), a predatory freshwater fish species feeding on invertebrates and fish, was originally confined to the temperate waters of the northern hemisphere, mainly Europe and North America, although representatives have been introduced to Australia, New Zealand and South Africa.

In Italy, in the North-East sector of the Po basin, the presence of perch has been documented for centuries, while in Central Italy this species is mainly present in the lakes of the Umbria and Latium regions (Bruno & Maugeri, 1992; Gandolfi, Zerunian, Torricelli, & Marconato, 1991). In the Lakes of Latium, perch is one of the fish species more representative of the professional fishery and local gastronomy. Here, special incubators have been established for the artificial reproduction of fry used in the stock enhancement of perch.

Within 2–3 years, when the body length is 15–25 cm, perch reaches sexual maturity. The average length of perch is 20–25 cm but it may vary depending on the environmental conditions: some specimens reach 45 cm, others may show dwarfism signs when living at a high population density.

It is well known that the quality of seafood products is dependent on the genetic basis and on the characteristics of the environment (pH, salinity and temperature of the water, composition of phyto- and zooplankton during the year, presence of other fish species, etc.).

Seafood safety is strictly dependent on the hygienic quality of the aquatic environment as well as on the different phases of the seafood production chain, from fishing to the treatments on-board and after landing. Fish products, in fact, are particularly susceptible to contamination, especially those from freshwater environments characterised by slow water exchange and high antropic contamination. The presence of organochlorine pesticides and polychlorinated biphenyls (PCBs) in the aquatic environments represents one of the most debated environmental questions due to their ubiquitous presence, accumulation in the food chain and incidence on public health (Smith & Gangolli, 2002). In the environment, they are persistent in soil and water and accumulate in sediments; in living organisms, due to their lipophilic nature, these substances accumulate in lipids. Therefore, the contamination level of a fish species may be affected by its lipid content, age, feeding behaviour and environmental pollution.

In the present work, the chemical and nutritional characteristics of perch caught in three lakes of Latium having volcanic (Bolsena and Bracciano Lakes) or artificial (Salto Lake) origin, were monitored in different months of the year. The feeding behaviour of perch from the three lakes was evaluated by means of the qualitative analysis of their stomach contents. Moreover, in the muscle tissue of fish were determined the levels of mercury, organochlorine pesticides and polychlorinated biphenyls residues. The aims of the study were the evaluation of the nutritional quality and safety of fish and the identification of differentiation elements, if any, among fish from either volcanic or artificial lakes.

2. Materials and methods

2.1. Study design and fish sampling

The study was conducted in collaboration with local fishermen who provided fish samples at seasonal intervals. Perch (*P. fluviatilis*) samples were harvested in December 2001 and in February, June and September 2002 from three lakes of Latium (Central Italy): Bolsena Lake, Bracciano Lake and Salto Lake.

Fish were caught by gillnets. All fish were immediately dipped in a mixture of water and ice to block any digestive system that would potentially hinder the identification in the stomach of the ingested preys. At landing, perch were transferred in polystyrene boxes containing ice and transported under refrigerated conditions (4 °C) to the laboratories for the analysis of the stomach content and for chemical determinations.

Upon arrival at the National Research Institute for Food and Nutrition, fish for nutrient determination were singularly measured for total body weight and total body length and immediately gutted. Perch from the three lakes were spawning in December and in February. Viscera were weighed and their percent of total body weight calculated. Soon after, fish were beheaded, washed, filleted, vacuum-

packed, and frozen at −75 °C to be analysed within one week. Fish for organic pollutant determinations were frozen at −75 °C without any prior treatment.

Within each seasonal sampling, 2–3 pools of fish, each composed of 4–6 specimens of comparable body size, were analysed separately in duplicate for nutritional evaluations. The weight of the specimens analysed from the three lakes was 100–120 g, which corresponds to the most marketed size of perch. In one occasion (February 2002) perch from Salto Lake were also analysed at different commercial sizes, 60 and 400 g total body weight, for a comparison of the chemical composition of different fish sizes. Analyses on organochlorinated pollutants were performed on samples (100–120 g body weight) harvested in September 2002.

2.2. Aquatic environments

The Bolsena Lake, with a surface of 114 km^2 and a maximum depth of about 150 m, is the fifth largest lake in Italy and the biggest one among those of volcanic origin. Located at 305 m above the sea level, the lake, characterised by a subcircular shape, receives its main water contribution by rainfall since the hydrographic network of that area is characterised by scanty waterways. Its only effluent is the river Marta. The Bolsena Lake is mesotrophic and rich in solutes. It is rich in phyto- and zooplankton, the basis of the food chain, as well as of algae belonging to the genus *Chara*, that represent a food source for many aquatic organisms. The phytoplankton is mainly represented both quantitatively and qualitatively by Cyanophyceae, Diatoms, Peridiniaceae, Chlorophyceae and Microflagellates. As regards zooplankton, Crustaceans (Copepoda and Cladocera), Rotifera and plenty of benthic taxa belonging to Annelida and to the entomophauna (larval phases) are mainly present. European eel, trout, whitefish, perch and mullet are the species introduced in the lake by stock enhancement, an activity already started by the end of 19th century. The physico-chemical characteristics of the lake water are: pH 8.4, temperature ranging between 9–10 °C in winter and 20–27 °C in summer.

The Bracciano Lake is a typical volcanic lake characterised by a subcircular shape. Located at 164 m above the sea level, the Bracciano Lake is 57.5 km^2 wide, has a diameter of 9 km and reaches a maximum depth of 164 m. Various subterranean springs and thermomineral waters act as tributaries of the lake. The Arrone River and the Paolo aqueduct, bringing water to the city of Rome, are its two effluents. The quality of the Bracciano Lake water is quite high. The lake is an important reservoir of drinkable water for Rome and some minor municipalities in the surroundings. Like the Bolsena Lake, this lake is rich in macroalgae belonging to the genus *Chara*, a species proliferating in aquatic environments with a poor eutrophisation level. The submerged meadows of macroalgae and macrophytes are in a good vegetative state. The lake has also a wide population of phytoplankton (Cyanophyceae, Chlorophyceae, Cryptophyceae, Diatoms, Peridiniaceae). As a consequence