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INFLUENCE OF COOKING METHODS OVER THE HEAVY METAL AND LIPID CONTENT OF FISH MEAT

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Abstract

Fish is a major source of minerals and polyunsaturated fatty acids for humans. However, it may sometimes contain unwanted components such as heavy metals. The aim of the study was to find whether the heavy metal content and the lipids of fish meat may be influenced by cooking methods. Chromium, nickel, cadmium and lead contents were assessed in cooked fish meat of four freshwater finfish species: bream, rapacious carp, carassius and perch, from Sulina Arm and its auxiliary channels. There were used four cooking methods: grilling, frying, microwaving and baking. The lead content varied between 0.08 and 0.14 mg/kg. There were no significant differences (P>0.05) in lead amounts between the uncoocked, grilled, fried, baked and microwaved fish meat. Nickel content was lower in grilled fish meat. Chromium amounts in grilled and microwaved meat were also significantly low (P<0.05). Cadmium was detected in the raw and fried meat, in rapacious carp and carassius fillets. All the cooking methods used for the study, especially baking, induced significant decreases in the lipids content (P <0.05). The obtained results indicated grilling, microwaving and baking as suitable for lowering the initial content of heavy metals and lipids in the studied fish fillets.

Key words: freshwater fish; preparation methods;rapacious carp; carassius fillet.

Introduction

Fish meat has a special nutritive value due to its content of high quality proteins, fats rich in polyunsaturated fatty acids with a high efficiency in human body, vitamins (especially A and D), and due to its high content in minerals like iron, phosphorus, potassium and magnesium [1].

Certain concentrations of chromium (Cr) and nickel (Ni), which are usually present in fish meat, are essential for human body [2]. However, traces of heavy metals may be present in fish meat too, thus threatening consumers' health. Polluted aquatic environments almost invariably facilitate fish meat contamination by heavy metals (e.g. lead, cadmium, mercury, copper, zinc), as well as by other type of pollutants, which reach water streams through industrial waste or by other human activities with environmental impact. Most of the heavy metals and their compounds are considered carcinogenic for consumer [3].

It has been inferred that the mineral content of fish meat can be influenced by processing or cooking methods [4, 5]. Therefore, it is important that concentrations of trace minerals in raw and cooked fish to be determined. Fish lipids contain high amounts of fatty acids within their structure (C_{14}-C_{28}); of them, at least 40% are unsaturated fats. This causes a high susceptibility of fish lipids to oxidation and peroxidation processes.

Different methods of cooking fish meat lead to partial melting of the fat, with partial discharge of it as juice. Peroxidation of polyunsaturated fatty acids also occurs, leading to the formation of peroxides, hydroperoxides and aldehydes, or negatively influencing the meat quality [1].

In this context, the present paper aims at determining the content of Cr, Ni, Cd and Pb from the meat of four freshwater fish species: bream (*Abramis brama*), carp (*Carrassius auratus*), perch (*Perca fluviatilis*) and rapacious carp (*Aspius aspius*), originated from Sulina Arm and its auxiliary channels. The main objective was to highlight how the concentration of these heavy metals can be affected by different processing or cooking methods, and to evaluate the way that these methods may influence the lipid content in fish meat cooking processes.

Material and method

Each of the freshwater fish species were collected for the study during March-April 2012. We used fish weighing on average 250-300 g, and about 20-25 cm long. Heavier weights and lengths, of about 800 g and 35-40 cm, were used for rapacious carp species. They were kept in an ice chest and transported to the laboratory. Fish were gutted, washed with tap water and filleted, and then fish fillets were divided into three groups (eight fillets per fish). The first group was raw fish – not cooked (control group). The other two groups (two replicates of each type of fish) were cooked in the microwave oven (2.450 MHz, 5 min), baked in the oven (200^0C, 20 min), in the grill oven (200^0C , 11 min) and fried (200^0C, 5 min) in sunflower oil. Raw and cooked samples were homogenized in a stainless-steel meat mince. Fish samples were digested using concentrated nitric acid (HNO_3 1,4g/ml, Merk) [6]. The digest was transferred to a 50-mL volumetric flask and made up to volume with deionized water. A blank digest was carried out in the same way.

All metals were determined against aqueous and using a PERKIN ELMER-USA spectrophotometer by atomic absorption spectrophotometry with a graphite oven (GF-AAS). The metal concentration was expressed as mg metal/kg dry weight (ppm). For total lipids concentration, the tissue sample was homogenized and subjected to extraction with chloroform-methanol mixture (2:1) for 2 hours. Total lipids were determined in chloroformo-methanolic extract obtained by centrifugation, based on the reaction of fosfovanilina with the acid(the lipid concentration expressed in g/100g tissue) [7].

Results and discussions

The values of the heavy metals content in cooked meat compared with raw fish are shown in the table 1, below.

Table 1. The mean heavy metal concentrations of the raw and cooked meat from bream, perch, rapacious carp and carassius

No.	Product type	Cooking methods	Chemical element (mg/kg dry weight)			
			Pb (x±Sx)	Cr (x±Sx)	Cd (x±Sx)	Ni (x±Sx)
1	Sample Bream	Raw	0,12±0,01a	1,18±0,03 a	ND	0,40±0,03 a
		Grilled	0,10±0,05a	0,58±0,10 b	ND	0,26±0,10 b
		Fried	0,11±0,05a	1,28±0,02 a	ND	0,52±0,03 a
		Microwaved	0,08±0,02a	0,90±0,03 b	ND	0,50±0,11 a
		Backed	0,09±0,01a	1,19±0,04a	ND	0,31±0,04 a
2	Sample Perch	Raw	0,13±0,01 a	1,22±0,03 a	ND	0,45±0,03 a
		Grilled	0,11±0,05 a	0,60±0,10 b	ND	0,28±0,10 b
		Fried	0,12±0,05 a	1,30±0,02 a	ND	0,55±0,03 a
		Microwaved	0,08±0,03 a	1,01±0,03 b	ND	0,53±0,11 a
		Baked	0,09±0,01 a	1,20±0,04 a	ND	0,40±0,04 a
3	Sample Rapacious carp	Raw	0,14±0,01 a	1,40±0,03 a	0,04 ±0,1	0,56±0,04 a
		Grilled	0,12±0,05 a	0,80±0,10 b	ND	0,30±0,10 b
		Fried	0,13±0,05 a	1,42±0,02 a	0,03±0,1	0,63±0,03 a
		Microwaved	0,10±0,03 a	1,11±0,03 b	ND	0,59±0,11 a
		Backed	0,11±0,01 a	1,27±0,05a	ND	0,35±0,04 a
4	Sample Carassius	Raw	0,13±0,01a	1,28±0,03 a	0,05±0,1	0,50±0,04a
		Grilled	0,11±0,05 a	0,78±0,10 b	ND	0,35±0,10b
		Fried	0,12±0,05 a	1,40±0,02 a	0,03±0,1	0,60±0,03a
		Microwaved	0,08±0,03 a	1,08±0,03 b	ND	0,52±0,11a
		Backed	0,10±0,01 a	1,20±0,04 a	ND	0,40±0,04a

•ND, not determined (below the limits of detection); Values are shown as mean ± standard deviation;
• Within the column, values with different letters(a-b) are significantly different ($P < 0.05$), values without letters(a-a) are not significantly different ($P > 0.05$).

Lead (Pb) concentrations in raw fish had values between 0.12-0.14 mg/kg in all types of fish investigated. There was no significant difference in Pb concentrations between the raw, grilled, fried, microwave-cooked and baked fish (P>0.05). A previous study on the effect of cooking methods on heavy metal concentrations of African catfish done by Ersoy (2011) correlates with our results. Chromium (Cr) concentrations in raw fish had values between 1.18-1.40 mg/kg in all types of fish investigated. The highest value was found in the fried meat as 1.42 mg/kg, from rapacious carp, while the lowest value was detected in the grilled meat as 0.58 mg/kg, from bream. The decrease in Cr concentration was significant (P< 0.05) for grilling and microwave cooking methods when compared with the raw control. Ersoy (2011) showed higher values of Cr levels in African catfish fried meat.

The cadmium (Cd) concentrations of raw, baked, grilled, microwave-cooked and fried samples of bream and perch were not detectable (below limits of detection, 0.02 mg/kg). Cd was detected in samples of raw meat and fried rapacious carp and carassius and, in our opinion, the increase of metal concentrations may be related to evaporation during frying.

The Nickel (Ni) concentration of raw fish had values between 0.40-0.58 mg/kg in all types of fish investigated. The increase in Ni concentrations of microwave-cooked and fried samples is slightly higher, when compared with the grilled fish ($P< 0.05$). `

Ni concentrations in cooked samples are similar to those reported by Ersoy et al. (2006), who found that Ni content varied between 0.21 - 0.93 mg / kg in grilled, fried, microwave-cooked and baked sea bass.

Total lipid content found in the cooked meat of the studied freswhater fish are shown in the table 2, below. The highest levels were found in the raw bream meat, whereas the lowest were in carassius and rapacious carp (Table 2).

Table 2. Total lipid content in cooked meat of perch, bream, carassius and rapacious carp

No.	**Product type**	**Cooking methods**	**Total lipids**
			g / 100 g tissue(x±Sx)
1	Sample Bream	Raw, Grilled, Fried, Microwaved, Backed	9,2±0,10 a 5,1 ±0,10 b 6,1 ±0,20 b 5,9±0,10 b 2,7±0,15 b
2	Sample Perch	Raw, Grilled, Fried, Microwaved, Baked	7,8±0,10a 4,3±0,20 b 5,2±0,15 b 4,5 ±0,10 b 1,5 ±0,10 b
3	Sample Rapacious carp	Raw, Grilled, Fried, Microwaved, Backed	6,1±0,10 a 3,8±0,20 b 4,9±0,15 b 4,2±0,10 b 0,9 ±0,10 b
4	Sample Carassius	Raw, Grilled, Fried, Microwaved, Backed	2,1±0,10 a 1,4±0,10 b 1,8 ±0,15 b 1,6±0,10 b 0,6±0,20 b

• Values are shown as mean ± standard deviation;
• Within the column, values with different letters(a-b) are significantly different ($P < 0.05$), values without letters(b-b) are not significantly different ($P > 0.05$).

All methods of cooking, especially backing, induced significant decreases in the concentration of lipids within the studied fish meat samples *($P < 0.05$)*. Total lipid concentration decreased by cooking meat fish is highlighted and Ionescu E. et al. (2010).

Conclusions

Of all the species investigated, rapacious carp raw meat had the highest content of heavy metals.

Among all types of fish cooking methods used in the study, frying showed a more pronounced effect on the heavy metal meat content. Baking, microwaving and grilling the fish meat lead to a moderate decrease in heavy metals load during the cooking process.

By choosing suitable methods of cooking, it is possible that the heavy metal concentration, initially present into fish meat, to be reduced. Along with the heavy metals decrease by cooking, significant losses of the total lipids content in the studied fish meat was recorded as well.

Further studies need to be performed on cooking methods at different conditions (i.e. time, temperature, cooking mediums), aimed at reducing the dangerous effect of heavy metals in fish meat.

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