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Not Simply a Matter of Fish Intake

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Abstract: *Background and Aims*: Recent findings have highlighted enhanced fish consumption as a potential measure to increase intake of healthy fatty acids, particularly omega-3. The generalizability of this recommendation, however, may fall short of differences in fish species and cooking techniques. Hence, we investigated how these 2 variables affect the lipid content in fish flesh.

Methods and Results: Nine species of freshwater, deep sea or shore fish were grilled, steamed or fried with or without the addition of soybean oil, olive oil or butter. The lipid composition was analysed and a significant difference was observed in cholesterol, saturated fatty acids, polyunsaturated fatty acids, omega-3 fatty acids and omega-6 fatty acids contents between species ($p<0.05$). The use of soybean or olive oil was associated with a significant change in flesh concentration of polyunsaturated, omega-3 and omega-6 fatty acids ($p<0.05$).

Conclusion: This study calls attention to the specific lipid content that must be expected from different fish species and cooking techniques.

Keywords: Fish flesh; lipid composition; cooking methods, omega-3 fatty acids, omega-6 fatty acids.

INTRODUCTION

It has been generally accepted that increased fish consumption may decrease the incidence of coronary heart disease (CHD). Indeed, a recent meta-analysis revealed that even low consumption of fish could reduce CHD mortality [1]. Recently, the regular ingestion of hake was associated with a decrease in low-density lipoprotein cholesterol (LDL-C), waist circumference, and blood pressure in individuals with metabolic syndrome, suggesting that fish intake may also be used to improve metabolic conditions [2]. Long-chain n-3 fatty acids (n-3 LCFA) are thought to be the major player in conveying these benefits [3]. Accordingly, international guidelines have recommended the intake of at least 2 or 3 portions of fish per week as a source n-3 LCFA for the prevention of cardiovascular disease [4].

Although observational data and clinical trials testing the effects of regular intake of isolated n−3 LCFA have supported its benefits in cardiovascular prevention, such evidence could not be extrapolated to fish intake [5]. Fish flesh content of n-3 LCFA may be influenced by their genetic backgrounds and habitats [5]. In addition, broiled and baked fish, but not fried fish and fish sandwiches, are associated with a lower incidence of CHD [6]. Thus, it is plausible to assume that some elements ingested with fish could be influenced by a combination of fish species and cooking methods. If so, the general recommendation of increasing fish intake may not necessarily provide similar supplementation of fatty acids and more specifically n-3 LCFA. In this context, we investigated how different cooking methods and different fish species or habitats affect lipid composition in fish flesh.

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MATERIALS AND METHODS

From freshwater we collected the following: pirarucu (*Arapaima gigas*), rainbow trout (*Oncorhynchus mykiss*) and filhote (*Brachyplatystoma filamentosum*). From deep sea we collected: whiting (*Meriangius meriangus*), Black Rockfish (*Sebastes melanops*) and cherne (*Epinephelus itajara*). From the shore we selected: Namorado Sandperch (*Pseudopercis numida*), hake (*Cynoscion leiarchus*) and sardines (*Sardinella brasiliensis*). The fish were obtained from the local market (caught on the same day) and subsequently gutted, washed, and cooked using different techniques (grilled, steam cooked and fried) as published elsewhere [7] using or not soybean oil, olive oil or butter. The lipid composition was analysed in triplicate by the Food Technology Institute - Meat Technology Center, São Paulo, SP, Brazil, according to established methods [8, 9].

Since the fresh flesh of tuna, mackerel and salmon is not often found in Brazilian marketing, we avoided their use in order to prevent interferences of freezing and thawing processes in the analyses.

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Data are presented as mean ± standard deviation for normally distributed data and as median (interquartile range) for non-parametric data. Analysis of variance was used for normal data and Kruskal-Wallis for skewed data. A two-sided $p<0.05$ was considered significant. SPSS software version 21.0 was used for all analyses.

RESULTS

There was a significant difference in lipid content between fish species Table **1**. The cholesterol, saturated fatty acids, polyunsaturated fatty acids and omega-6 fatty acids contents were higher in freshwater fish. Omega-3 fatty acids were higher in coastal fish, particularly hake.

The effects of different cooking methods on lipid composition are presented in Table **2**. There was no difference in saturated fatty acids or cholesterol content obtained from the different cooking methods. However, fish fried in soybean oil showed a higher concentration of polyunsaturated fatty acids, omega-3 fatty acids and omega-6 fatty acids than grilled or steamed fish.

DISCUSSION

The main findings of this study are that the cooking method and fish species are important determinants of the resulting lipid content. Consistent with previous studies, feeding behaviour and genetic background are reflected in the differences in lipid content of fish flesh [5]. Our study shows that shore fish, particularly hake, is the richest in n-3 LCFA (up to an 11-fold increase). In contrast, we found that deep-sea fish are the poorest in these fatty acids.

In addition, polyunsaturated fatty acids, n-3 and n-6 LCFA of fish were also influenced by the cooking methods. The use of butter, soybean or olive oil in the cooking method may lead to a substantial difference in the resulting fish flesh lipid content. This result is consistent with the evidence of distinct impact of fish intake in CHD according to the preparation method [6]. Thus, although the general consumption of fish is healthy, the expected metabolic and cardiovascular benefit will be unpredictable without a strict discrimination of the fish species and cooking methods.

Table 1. The lipid content of fish species.

	Pirarucu	Rainbow trout	Filhote	Whiting	Black rockfish	Cherne	Namorado sandperch	Hake	Sardines	p
Cholesterol, mg/100g	108 ± 30	80 ± 6	78 ± 9.4	62 ± 10	77 ± 8.5	90 ± 8.5	78 ± 8.4	92 ± 6	83 ± 5.6	≤0.001
Saturated fatty acids g/100g	3.0 ± 1.6	2.4 ± 0.3	4.7 ± 0.5	0.6 ± 0.2	1.0 ± 0.3	1.5 ± 0.6	0.9 ± 0.3	2.5 ± 0.2	2.7 ± 0.6	≤0.001
Polyunsaturated fatty acids g/100g	0.2(1.4)	1.3(0.4)	1.8(0.8)	0.05(0.3)	0.07(0.3)	0.58(0.8)	0.7(1.5)	2.5(5.0)	3.0(6.8)	0.001
Omega-3 fatty acids, g/100g	0.2 ± 0.25	0.12 ± 0.03	0.31 ± 0.1	0.03 ± 0.05	0.1 ± 0.09	0.3 ± 0.1	0.29 ± 0.16	1.17± 0.5	0.95 ± 0.6	≤0.001
Omega-6 fatty acids, g/100g	0.2(0.9)	1.15(0.2)	1.5(0.6)	0.04(0.2)	0.06(0.3)	0.35(0.6)	0.3(1.2)	1.5(4.1)	1.9(5.5)	0.004

Data expressed as mean ± SD for parametric variables and expressed as median (Interquartile range) for non-parametric variables.

Table 2. The lipid content of fish species cooked by various methods.

	Fried with soybean oil	Fried with olive oil	Grilled	Steamed without oil	Steamed with soybean oil	Steamed with olive oil	Steamed with butter	P
Cholesterol, mg/100g	83 ± 9	83 ± 11	86 ± 11	79 ± 15	79 ± 30	79 ± 23	76 ± 14	0.94
Saturated fatty acids g/100g	1.8 ± 1	1.67 ± 0.8	1.9 ± 1.2	2.1 ± 1.7	2.4 ± 1.9	2.2 ± 1.8	2.3 ± 1.3	0.92
Polyunsaturated fatty acids g/100g	2.5 (5.7)	1.0 (1.2)	0.3 (1.6)	0.1 (1.61)	0.92 (1.52)	0.32 (1.28)	0.45 (1.19)	≤0.001
Omega-3 fatty acids, g/100g	0.77 ± 0.71	0.51 ± 0.46	0.27 ± 0.32	0.11 ± 0.16	0.19 ± 0.14	0.14 ± 0.16	0.14 ± 0.10	0.009
Omega-6 fatty acids, g/100g	2.2 (4.2)	0.55 (0.62)	0.15 (0.61)	0.08 (1.35)	0.77 (1.1)	0.24 (1.04)	0.18 (1.01)	≤0.001

Data expressed as mean ± SD for parametric variables and expressed as median (Interquartile range) for non-parametric variables.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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