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Cholesterol content in fish meat

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Abstract

The cholesterol content in fish meat was determined. The samples came from a market network of the Czech Republic in a range of commonly available freshwater and saltwater fish. Assessment was carried out using reverse phase liquid chromatography with an isocratic elution system. The cholesterol content in fish meat was varied considerably and differed depending on the species of fish. Actual concentrations were in the range of 256.73 ± 10.74 mg·kg^{-1} for salmon up to 982.80 ± 64.45 mg·kg^{-1} for mackerel. No dependence, however, was found on the fat content in the fish meat, or on either the freshwater or saltwater origin of the fish.

Fish, cholesterol, nutrition, HPLC

Introduction

Because of the irreplaceable role of cholesterol within an organism, its presence in foodstuffs of animal origin is understandable and inevitable. In those foods in which it does not play a role in the formation of emulsions, for example meat and meat products, its content is not connected to fat content. In the case of foodstuffs such as milk and eggs in which it is involved in the emulsification of fat, the opposite is true. Cholesterol is the most important zoosterol. This alicyclic alcohol is a key component of many biochemical processes and is therefore a natural part of animal tissues. Cholesterol is the precursor of bile acids, provitamin D3 and steroid hormones. It plays an extraordinary role as a part of cell membranes, where it is dynamically involved in their fluidity and rigidity.

The exogenous intake of cholesterol is one of the factors affecting the level of LDL cholesterol in the blood serum of the human population. Understanding the content of cholesterol in food and assessing the intake of cholesterol from food is therefore important when addressing health problems related to the level of LDL cholesterol. In view of the fact, that daily exogenous cholesterol intake should not exceed 300 mg, an informed consumer tends to look for foodstuffs with a low or reduced cholesterol content. The US FDA has established the following rules for the labeling of these products: „cholesterol free“ for foodstuffs containing less than 2 mg of cholesterol per portion, „low-cholesterol content“ for 20 mg of cholesterol and less per portion, „reduced cholesterol content“ with more than 25% less cholesterol than for similar products (Roginski et al. 2002). National legislation, as amended by Decree 330/2009 Sb. relating to the labeling of the nutritional value of food, requires that the cholesterol content be indicated in food that is being marketed on the condition that the cholesterol is included in the nutritional claim.

Chromatographic methods are more and more frequently being used to determine cholesterol content, especially gas-liquid chromatography. The subject of our study was to determine the overall cholesterol in selected types of freshwater and saltwater fish available in market networks.

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Materials and Methods

The Samples

Samples of fresh fish were purchased at market chains in the Brno Region and each species was represented by 6 samples in the following breakdown: salmon steak, whole trout, carp halves, pangasius filet, black cod filet, bib filet, and whole mackerel.

Pre-analytical Preparation of the Samples

One gram of homogenized skinned fish meat was placed in a 50 ml flask with a solution of 10 ml of potassium hydroxide in methanol (l part 10 M KOH and 9 parts methanol, v/v). After the addition of a solution of 0.3 ml of stigmasterol, the mixture was heated under reflux for 30 minutes.

When the mixture was cooled to laboratory temperature, 5 ml of deionized water was added. After mixing, 10 ml of hexane was added and intensively agitated for 10 minutes. The hexane layer was removed with the aid of a separation attachment and evaporated dry on a rotary evaporator. The residue was dissolved in 1 ml of methanol and filtered through a nylon membrane filter. The cholesterol content was established using reverse-phase liquid chromatography with an isocratic elution and detection at 205 nm.

Preparation of Standards

Working solutions were prepared from a stock solution of cholesterol with a concentration of 1000 $mg \cdot l^{-1}$, which were done in methanol with a concentration range of 1 - 500 $mg.l^{-1}$. These solutions were used to create calibration curves.

The solution of stigmasterol, which was an internal standard, had a concentration of 0.1 % and was prepared by dissolving it in a mixture of methanol and hexane (23:2, v/v).

Chromatographic Determination

Measurement was carried out on an Alliance liquid chromatography unit (Waters, USA) with a diode-array detector in isocratic mode. The mobile phase was a mixture of methanol and water with a 95:5 ratio, the flow rate of the mobile phase was 1 $ml.min.^{-1}$, the injection volume was 10 µl, and the column temperature was 35 °C. Separation was carried out using a column with a reverse phase C8 - Zorbax Eclipse XDB-C8, 4.6 x 150 mm with a particle size of 5 µm (Agilent, USA).

Results and Discussion

Fish is associated with an extraordinary quantity of nutritional positives, but the consumption of fish in the Czech Republic is not at a desirable level. Its advantage is not only its high nutritional value, but also the simplicity of its culinary preparation due to its proportion of myofibrillar, sarcoplasmic and stromatic proteins, together with their different anatomical-histological arrangement - unlike in other meats. Additionally, fish is at the forefront for its better digestibility, associated with its faster trypsin and chymotrypsin hydrolysis, and to the lower thermolability of fish proteins (Baltes 2000; Belitz and Grosch 1992, 2004).

A lot of information has already been published about the nutritional value of fish. Its obvious uniqueness is indeed its amount of polyen fatty acids of the Omega 3 variety, from which series-3 prostaglandins and thromboxaness (PGI_3 a TXA_3) and series-5 leukotrienes (LTB_5, LTC_5, LTD_5) are made, which when used in the organism have a number of positive effects (in vasodilatation and antihypertension and in other effects influencing the slowdown of atherogenesis).

Just as with other foodstuffs of animal origin, fish is also a source of cholesterol, which is particularly present in their cell membranes. It is therefore not possible to carry out a fat count of the type that is labeled, for example, on milk and dairy products. Many older resources list the cholesterol content in some fish species, but new studies suggest that these values need to be verified, not only in regards to analytical procedures, but also intravital factors in fish farming. Loukas et al. (2010), for example, found that the cholesterol content in the meat from farmed fish is significantly higher (for some species up to double) than that of fish from wild fisheries.

The actual cholesterol content provided us in the samples of fresh fish analyzed in the study ranged from 256.73 ± 10.74 $mg \cdot kg^{-1}$ for salmon to 982.80 ± 64.45 $mg \cdot kg^{-1}$ for mackerel. No significant correlation to the fat content in fish was found. A chromatographic

Table 1. Cholesterol values in fish meat - including statistical parameters

Fish type	Cholesterol (mg·kg^{-1})			Fat (%)
	Average	SD	RSD %	
Pangasius	627.41	32.39	5.2	1.0
Trout	627.16	40.05	6.4	2.7
Carp	690.92	32.49	4.7	7.0
Salmon	256.73	10.84	4.2	14
Black cod	864.11	25.56	3.0	0.6
Bib	578.27	22.22	3.8	0.6
Mackerel	982.80	64.45	6.6	12

record is provided in Figure 1 of the cholesterol recorded in the meat of cod. The cholesterol content for each species of fish, including statistical parameters, is shown in Figure 1 and in Table 1. It is clear from the results that the variability in the cholesterol content is important, but is independent of the division into freshwater and saltwater fish. In comparison with the literary data, the values that we found in carp are similar to those findings published by Spiric et al. (2009), who, according to the methods used, recorded 37.65 to 65.44 mg/100 g of cholesterol.

It can be shown from the information provided that the cholesterol intake from common fish species from the market networks is about 50-200 mg of cholesterol in 200 g portions of fish. Whereas the first values (salmon) allow us to talk about low-cholesterol food, the cholesterol content in cod and, especially, mackerel is closer to the content in other species.

Conclusions

The current consumer is more and more frequently influenced by nutritional information when selecting food. The reason for this is the fact that the percentage of the population that is aware of the diet influence has the incidence of many diseases is increasing.

The aim of this pilot study was to find out the actual cholesterol content in fish meat because the literary data are contradictory and incomplete.

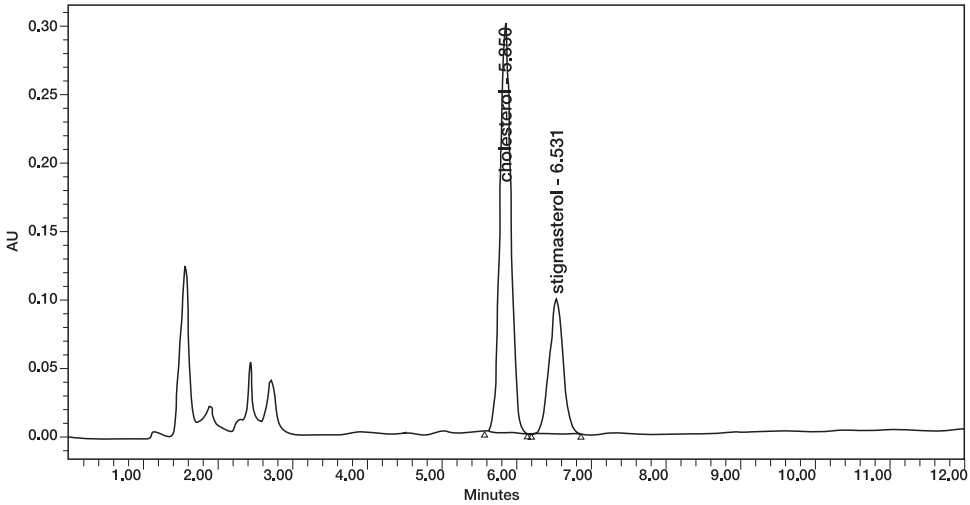

Fig. 1. Chromatogram of the cholesterol in the meat of cod sample

Conditions for the determination of HPLC:
Column Zorbax Eclipse XDB-C8, 4.6x150 mm, 5µm.
Mobile phase - 95% methanol: 5% water, flow rate 1 ml/min, isocratic elution, UV detection at 205 nm.
Internal standard stigmasterol.

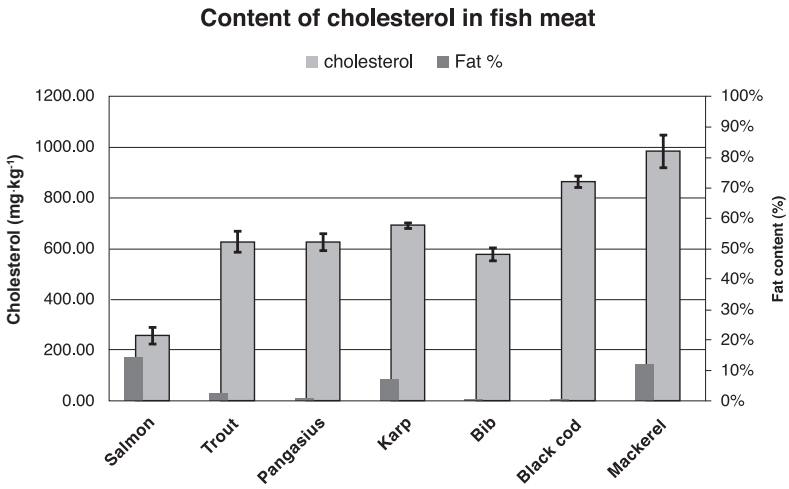

Fig. 2. Cholesterol values (average ± SD) in the fish meat

The pilot study shows that the intake of cholesterol from common fish species from market networks is about 50-200 mg of cholesterol in 200 g portions of fish, whereas the first values (salmon) allow us to talk about low-cholesterol food, the cholesterol content in cod and, especially, mackerel is closer to the content in other species.

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References

Baltes W 2000: Łebensmitelchemie. Springer-Verlag Berlin, 470 pp.
Belitz HD, Grosch W 1992: Lehrbuch der Lebensmittelchemie. Vierte Auflage. Springer-Verlag Berlin, 966 pp.
Belitz HD, Grosch W, Shieberle P 2004: Food Chemistry. Springer-Verlag Berlin, 1070 pp.
Loukas V, Dimizas C, Sinanoglou VJ, Miniadis-Meimaroglou S. EPA, DHA, cholesterol and phospholipid content in Pagrus pagrus (cultured and wild), Trachinus draco and Trigla lyra from Mediterranean Sea. Chem. Phys.Lipids.*163*: 292 – 299
Roginski H, Fuquay JW, Fox PF 2003: Encyclopedia of Dairy Science. Academic Press, 2500 pp.
Spiric A, Vranic D, Trbovic D et al. Statistical evaluation of fatty acid profile and cholesterol content in fish (common carp) lipids obtained by different sample preparation procedures. Anal.chim.acta **672**: 66 – 71
Ministry of Health Decree No. 330/2009 Coll., on the labeling of nutritional values of food