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CHOLESTEROL CONTENT IN MEAT OF SOME *CYPRINIDAE*

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Abstract: The aim of this paper was to examine cholesterol content in meat of five *Cyprinidae* species: white bream (*Bllica bjoerkna L.*), carp bream (*Abramis brama L.*), baltic vimba (*Vimba vimba carinata Pallas*), zope (*Abramis balerus L.*) and crucian carp (*Carassius carassius gibelio Bloch*) from the river Danube. Cholesterol content was examined in the function of season factor and individual weight.

Cholesterol concentration in meat of white bream, carp bream, baltic vimba, zope and crucian carp is on average level below 20 mg/100 g of meat, which makes meat of these fish species nutritively very valuable. Cholesterol content is variable during the season. Its concentration in meat and in lipids is lowest during spring, during summer it increases and during autumn decreases, except in meat of white bream. Body weight has influence on cholesterol content when its concentration is expressed as % of cholesterol in lipids. Its content in lipids decreases with increasing of individual weight, except in meat of carp bream.

Key words: cholesterol, fish meat **,** season, weight.

I n t r o d u c t i o n

Heart and blood vessels diseases are the most frequent causes of death in highly and middle developed countries. Essentially, in the overwhelming majority (about 90%) there is aterosclerosis process. One of the most important factors of risk, which contributes to aterosclerosis occurrence, is, no doubt, the rise of cholesterol level in blood.

When we discuss effects of increasing alimentary cholesterol intake and its metabolism, it is necessary to keep in mind that cholesterol is a normal, structural

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element of all cell membranes of human and animal organisms. In addition in liver cells, cholesterol is necessary for the synthesis of bilious acids, and it is the starting point for the production of steroide hormone of gonadal and cortex of adrenal glands.

Cholesterol origin in organism is twofold. Around 2/3 of cholesterol (800-900 mg daily) develops by synthesis in the very cells and the rest has taken in with food. Today, it is considered that sufficient daily food intake is 100 -150 mg, but the fact is that it is much greater, Lepšanović et al. (1996).

Namely, from the aspect of cholesterol negative effects on organism, alimentary intake of aterogenic fatty acids (C10:0, C12:0, C14:0 and C16:0) and total lipids is essential too. In addition, the quantity of quoted nutritients defines aterogenic potential of each food.

Alimentary intake of mono and polyunsaturated fatty acids, especially of ω-6 and ω-3 group, which are present in significant quantity in fish lipids, has positive effects on free cholesterol level in blood, Gajić (1997).

Paniangvait et al. (1995) emphasize cholesterol aterogenity, but consider that there is also evidence of cytotoxicity of some cholesterol oxides as 25-hydroxy -cholesterol and cholestanetriol, which can be produced in the presence of free oxygen or oxiradicals. Also, their attitude is that aterogenity of some steroles and cholesterol oxides is not identical. They have found out that cholesterol level and its oxides in see foods are somewhat lower in relation to »red meats« (cattle meat).

Osada et al. (1993) conclude that cholesteroloxides occurrence in food is highly correlated with unsaturated fatty acids level. In addition, cholesterol content is increased in all samples which contain eicosapentaenoic acid EPA (20:5) ω-3 and docosahexaenoic acid DHA (22:6) ω-6 in higher concentration.

Oshima et al. (1993) found out high cholesterol oxidation stability in model systems without lipids under heating conditions. However, when lipids are present, cholesterol is unstable, especially in the presence of unsaturated lipids. The authors conclude that radicals produced by heating of polyunsaturated fatty acids act as accelerators of cholesterol oxidation, or more exactly cholesterol oxidation in fish products is emphasized by oxidative decomposition of polyunsatured fatty acids.

Cholesterol content in fish meat depends on species too. According to Iwasaki and Harada (1985), cholesterol content in fish meat ranges from 32 to 68 mg/100 g of meat. Although, the authors do not provide any explanation for these differences,it is evident from the results that in lean fish meat cholesterol content is lower, and is within the limits between 30 - 40 mg/100 g of meat, while in fatty fish it is higher.

Jhaveri et al.(1984) state differences in cholesterol content of different fish species, ranging from 15.80 - 80.65 mg /100 g meat. In fatty fish meat higher

cholesterol level was established compared to lean fish. When cholesterol content is calculated as cholesterol concentration in 100 g of fish meat lipids, it can be concluded that cholesterol concentration in 100 g of lipids is significantly higher in lean than in fatty fish, and is in the range between 0.95 - 5.04%.

Cholesterol content in fish meat can vary, even in related species which are living in the same area, and have similar eating habits, Krzynowek et al. (1984). Those authors have investigated the content of some nutrients, among others of cholesterol too, in the meat of three species of European hake from the family *Gadidae*, and have established that in their meat cholesterol content varies between 35.1 - 49.0 mg/100 g.

Jhavery and Constantinidis (1981) and Krytchsevsky et al. (1967) consider that cholesterol content in fish meat, shellfish and mollusks varies widely as a result of species affiliation, sex, season, quantity and quality of food and breeding conditions, and that differences caused by those factors can be very significant.

High cholesterol content in some fish meat (Krzynowek et al.,1982) followed, as a rule, by high polyunsaturated fatty acid content in their meat lipids. In addition, environmental conditions, especially water temperature, influence polyunsaturated fatty acid and cholesterol contents in meat. In organisms living in deeper and colder water, higher polyunsaturation of lipids, and probably cholesterol, in meat is physiologically caused. Results presented by Nettleton et al. (1990) are somewhat different. Cholesterol content in channel catfish (*Ictalurus punctatus)* is significantly lower during cold periods, or more exactly in February - 19.8 mg/100 g compared to warmer months during which it is in the 37.0 - 39.4 mg/100 g range . These authors have not linked cholesterol content and polyunsaturated fatty acid content, though their content in meat is highest in February, just when cholesterol is at the lowest level.

The data on the investigations of cholesterol content in freshwater fish meat are scarce. Souci et al. (1979) have established 72.0 mg/100 g of cholesterol in the meat of perch (*Perca fluviatilis L.*) and 55.0 mg/100 g in the meat of brown trout (*Salmo trutta m. fario L.*).

The aim of this investigation was to examine the influence of seasonal variation and individual body weight of some *Cyprinidae* species on cholesterol content in their meat.

Materials and Methods

The investigation was carried out on the meat of five freshwater fish species (*Cyprinidae*): white bream (*Bllica bjoerkna L.*), carp bream (*Abramis brama L.*), baltic vimba (*Vimba vimba carinata Pallas*), zope (*Abramis balerus L.*) and crucian carp (*Carassius carassius gibelio Bloch*).

Catch was done on the river Danube, on the stretch from 1171 to 1175 km of its flow in three seasons: spring (March-April), summer (June- July) and autumn (September-October).

In the scope of each examined fish species, during spring, summer and autumn, three experimental weight groups, 10 individuals in each, were formed depending on average hunting mass according to the scheme as follows:

Tab.1. - Weight groups of examined fish species

Fish species	Weight group		
	Light (L)	Medium (M)	Heavy (H)
White bream	≤ 150 g	151-200 g	> 200 g
Carp bream	≤ 300 g	301-500 g	> 500 g
Baltic vimba	≤ 200 g	201-300 g	> 300 g
Zope	≤ 150 g	151-200 g	> 200 g
Crucian carp	≤ 200 g	201-300 g	> 300 g

Muscle tissue with skin (fillet) from 10 individuals of each weight group during all three seasons used as a sample. Samples were passed twice through a grinder, plate with holes of ∅ 4 mm, and then homogenized and kept in polyethilene bags at the temperature from 0^0 - +4 ^{0}C until the analysis was to be done.

Lipid extraction was done by the method of Folch et al. (1957), and 10 g of a sample with the addition of KCl was used for extraction during purification of samples with water. Cholesterol content was determined spectrophotometrically at wave lengths of 490 nm by the method of Searcy and Berquist (1960) as modified by Bohac et al. (1988), while saponification was done by adding of 3% of pyrogalol.

Presented results represent average values for four replications.

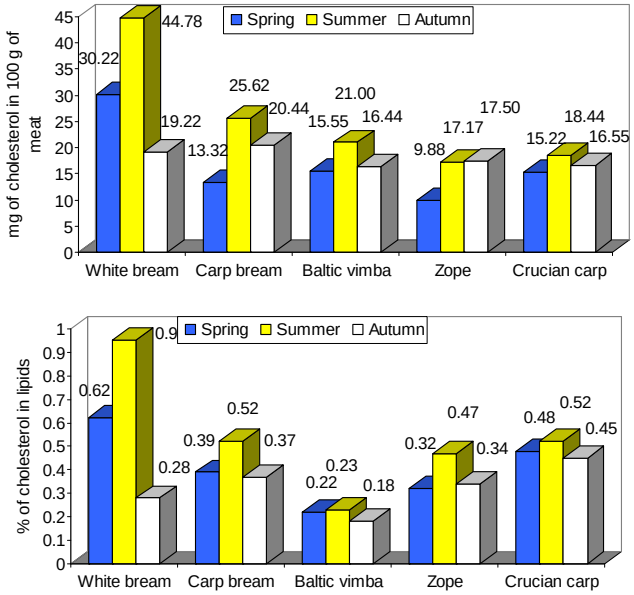
Cholesterol content, expressed as its concentration in lipids, was obtained by recalculation of cholesterol and lipid content in meat.

Results and Discussion

On the basis of data presented in graph. 1, we can conclude that cholesterol content in the meat of examined fish species is at low level. Its average value during the spring-autumn period ranges from 14.85 mg/100 g in zope meat to 31.40 mg/100 g in white bream meat. Cholesterol content in the meat of carp bream, baltic vimba, zope and crucian carp is below 20 mg/100 g of meat, which is significantly lower than the in meat of warm-blooded animals (40-60 mg/100 g of meat) Paningvait et al. (1995) and Souci et al. (1979).

During summer period intensive increase of cholesterol content was found, ranging from 21.15% in crucian carp meat to 92.34% in carp bream meat.

Intensification of metabolism and physiological process during warmer months increases the need of fish organism for this compound, which is intensively synthesized, Dukes (1975). We can assume that increase of cholesterol content in meat is a consequence of its higher alimentary intake too.



Graph.1. - Influence of season on cholesterol content in fish meat

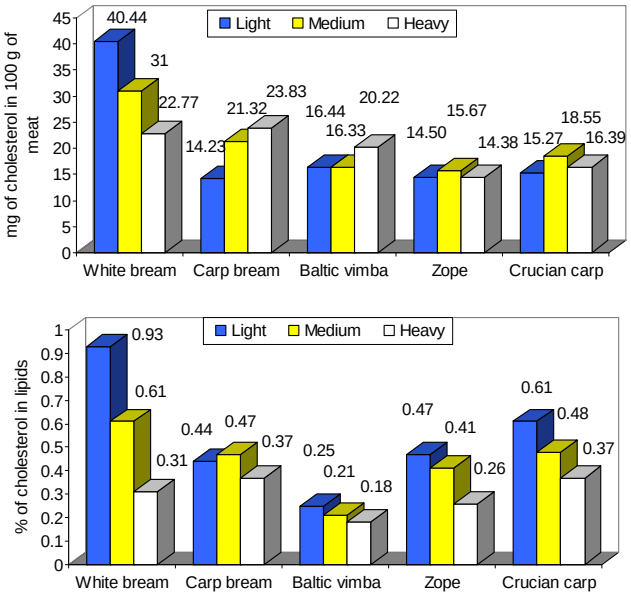
During autumn period in all fish species, except in zope, cholesterol content decreases in relation to summer. Its content in the fish of autumn catch exceeds spring values, except in white bream meat, where it is lower (46.40%).

Our results are in accordance with the results of Nettleton et al. (1990). The authors established that cholesterol content in meat of channel catfish is significantly lower in cold period than in warmer months of the year.

We can conclude that our results are within the range of those quoted by Jhavery et al. (1984), and values established for meat of white bream are very similar to the data reported by Iwasaki and Harada (1985) and Krzynovek et al. (1984), while cholesterol content established in the meat of other fishes was significantly lower than references cited. Average cholesterol content calculated as its concentration in lipids, during spring-autumn period was 0.21% in baltic vimba meat, 0.38% in zope meat, 0.43% in carp bream meat, 0.48% in crucian carp meat and 0.62% in white carp meat.

During summer period its concentration in lipids decreases to values similar to spring concentrations or lower than them.

Results presented in graph. 2 show that in the meat of white bream highest cholesterol content was found in L group - 40.44 mg/100 g of meat. In M group lower cholesterol content was found - 23.34%, and in H group its content was 22.77 mg/100 g of meat, which is 26.55% lower compared with M group.



Graph. 2. - Influence of body weight on cholesterol content in fish meat

A completely opposite trend was established for carp bream meat where in L group lowest content of this compound was found - 14.23 mg/100 g of meat, and marked increase in M group is evident in whose meat 49.82% cholesterol was found more. In the meat of heaviest individuals cholesterol content was highest - 23.83 mg/100 g of meat, which is 11.77% higher in relation to M group.

In the meat of baltic vimba very similar values for L and M group were established - 16.44 and 16.33 mg/100 g of meat, while in the meat of the heaviest fishes its content was by 23.82% higher than in to M group.

Cholesterol content in the meat of L group of zope amounted to 14.50 mg/100 g of meat and in M group it was by 8.06% higher. In the heaviest individuals of this species, its concentration in meat was somewhat lower - 8.23% compared to M group.

In the meat of crucian carp the same tendency of changes was established as in zope, but changes among weight groups are more expressive. The highest value was established in M group and it is higher than in L and H groups - 21.48 and 13.18%.

Cholesterol content in meat expressed as percentage concentration in lipids shows exceptionally clear and uniform change trends caused by the increase of individual weight. With the increase of body weight cholesterol content in lipids rapidly decreases in all examined cases, except in carp bream, where somewhat higher value was found in M than in L group.

The highest cholesterol concentration in lipids, in white carp, was established in L group - 0.93%, in M group it was 34.41% lower, and in H group compared to M group it was 49.18% lower too.

In carp bream, higher value was found by 6.82% in M group than in L group, while meat of H group contained 21.28% of cholesterol less than M group.

In the meat of baltic vimba, which contained the most lipids, Živković (2002) reported significantly lower oscillation of cholesterol content in the function of individual weight. The highest value - 0.25% was established in L group, while in M group its concentration was 16.00% lower, and in the heaviest individuals that decrease, compared with M group was 14.28%.

The highest cholesterol content in lipids was found in the lightest zope 0.47%, in M group it was 12.76% lower, while significantly higher difference was found between H and M groups - 36.58%.

In the meat of crucian carp decrease at the level of 21.31% was found between L and M, and 22.92% between M and H groups.

We are not able to compare our results for cholesterol content in meat of different fish weight groups directly with literature data, but we also must state a high disparity of change in trends in the examined fish species.

These variations can be explained by specific physiological demands of age category and weight group, respectively, within each species, which are views of Jhaveri and Constantinides (1981), Krzchsewski et al. (1967) as well as of Kryznovek et al. (1984) too.

Conclusion

Cholesterol concentration in the meat of white bream, carp bream, baltic vimba, zope and crucian carp has been at average level below 20 mg/100 g of meat, which makes meat of these fish species nutritively very valuable. Cholesterol content is variable during season. Its concentration in meat and in lipids is lowest during spring, during summer it increases and during autumn decreases, except in the meat of white bream. Body weight influences cholesterol content when its concentration is expressed as % of cholesterol in lipids. Its content in lipids decreases with increase of individual weight, except in the meat of carp bream.

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SADRŽAJ HOLESTEROLA U MESU POJEDINIH *CYPRINIDAE*

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R e z i m e

Jedan od najznačajnijih faktora rizika koji dovodi do razvoja ateroskleroze i bolesti srca i krvnih sudova je povišen nivo holesterola u krvi. Stoga je cilj ovog rada bio da se ispita sadržaj holesterola u mesu pet vrsta Ciprinida poreklom iz reke Dunav, u funkciji sezonskog faktora i mase jedinki.

Sadržaj holesterola u mesu, svih ispitivanih vrsta riba, je na niskom nivou. Njegova prosečna vrednost tokom perioda proleće-jesen kreće se od 14.85 mg/100g u mesu špicera, do 31.40 mg/100g u mesu krupatice. Sadržaj holesterola, u mesu deverike, plavonosa, špicera i babuške je ispod 20 mg/100g mesa, što su znatno niže vrednosti no u mesu toplokrvnih životinja.

Koncentracija holesterola u mesu i u masti najmanja je tokom proleća, tokom leta se povećava, a u toku jeseni smanjuje, osim u mesu krupatice. Masa trupa utiče na sadržaj holesterola u slučaju kada je njegova koncentracija iskazana kao % holesterola u masti. Njegov sadržaj u masti smanjuje se sa povećanjem mase jedinki, osim u mesu deverike.

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