

# BLACK SEA AND FRESHWATER FISH AS VALUABLE SOURCES OF VITAMIN D<sub>3</sub>

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## ABSTRACT

Fat soluble vitamins are essential nutrients in important biological processes in the human body. Vitamin D<sub>3</sub> (cholecalciferol) promotes and enhances the absorption and metabolism of calcium and phosphorus in our body. Nowadays there is a plethora of evidence suggesting that, in addition to its important role in maintaining bone health, vitamin D is involved in the amelioration of cell ageing and prevention of cardiovascular diseases, diabetes, immune dysfunctions and some cancers. This article presents information about vitamin D<sub>3</sub> contents in a broad range of fish species available on Bulgarian local fish markets. The aim is to increase consumers' awareness and encourage them to eat fish.

**Keywords:** *Bulgarian fish, cholecalciferol, fish tissue, health, RDI*

## INTRODUCTION

Vitamin D<sub>3</sub> (cholecalciferol) is synthesized by living cells in the skin or ingested by consumption of high-fat animal tissues (16). The human organism produces it endogenously by means of sunlight irradiation (4,13).

The biologically active form of vitamin D<sub>3</sub> (as a hormone in the human body) is 1, 25-dihydroxylated form (calcitriol). The hormonal functions of vitamin D<sub>3</sub> include regulation of bone and muscle health (skeletal and heart), the immune system, regulation of insulin and glucose levels, calcium and phosphorus metabolism. It increases the absorption and deposition of calcium in the bones, helps convert inorganic phosphorus to organic, stimulates bone

growth, prevents muscle cramps and bone fractures (5,13,23,28).

Sufficient amounts of vitamin D<sub>3</sub> in the body have a proven effect against the development of various diseases and/or disorders. A number of studies have demonstrated the beneficial effect of cholecalciferol supplementation in the prevention of cardiovascular diseases, high blood pressure, diabetes type I and II, osteoporosis, multiple sclerosis (11,12,13,28). Much discussed is the role of vitamin D<sub>3</sub> in the prevention of cancer (4,28).

Recommendations on the average daily intake of vitamins have been approved and implemented by healthcare organizations in many countries. They aimed at specific groups of individuals - by age and gender: infants and children (divided into subgroups according to age - months and years), adolescents, adults (three subgroups - women, men and over 65 years old), pregnant women and lactating women (2, 21).

It was found that people living in warm areas with more sunlight during the year do not need additional vitamin D supplementation. According to Holik et al., 1980, the required daily intake of vitamin D<sub>3</sub> can be obtained by 30 min daily exposure to sunlight

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of the skin of the shoulders unprotected by sunscreen products (12). Subsequent inclusion of cholecalciferol in the metabolism happens about three days after synthesis.

Recommendations for dietary intake of vitamin D<sub>3</sub> in different countries vary considerably, considering different geographical locations. The recommended daily doses are significantly higher in the Nordic countries (Sweden, Denmark and Norway) while they are lower in the Mediterranean region (Italy and France) (10,24).

Due to the fact that many studies have proven endemic vitamin D deficiency in the EU countries by 2011, healthcare organizations significantly increased the recommended quantities – 10 µg/day of cholecalciferol supplementation (2). At present, the recommended daily intake of vitamin D<sub>3</sub> in Bulgaria is twice lower (5 µg/day) (21).

Fish are traditionally viewed as key part of a healthy and balanced diet, because they are one of the best sources of vitamin D<sub>3</sub>. The main reason for this is that they consume enormous amounts of plankton, which is rich in precursors - previtamin D<sub>2</sub> and D<sub>3</sub>. Because of this, many researchers have studied cholecalciferol content in different fish species and fish samples - caviar (20,30), edible fish tissues (14,30), liver (14,30), gonads (14,30), kidney (14) and spleen (30).

Fat soluble vitamins needed for optimal human health are found in fish tissues, but their amounts vary considerably depending on the species, season and different representatives of a given fish species (23). Edible fish tissue provides a significant amount of the recommended daily intake (RDI) of vitamins A and E, and especially vitamin D<sub>3</sub> for humans (18).

The American Heart Association and FAO/WHO recommend at least two fish servings per week (1,8). In Bulgaria, this advice was described in Food-based Dietary Guidelines for Adults in Bulgaria (9), because, the consumption of fish is very low (4.5 kg annual per capita) compared to the average European levels (23 kg annual per capita) (8).

This article examines the nutritional and health benefits of fish as a valuable source of vitamin D<sub>3</sub> and presents useful information for these biologically active components for Bulgarian consumers.

## MATERIAL AND METHODS

Samples of fish were purchased from Varna local fish market. The sample preparation was performed using the method of Dobreva et al. (7). The reversed phase high performance liquid chromatography (HPLC) was used for the vitamin analysis. The recovery rates were calculated utilizing the external standard method. The results were expressed as µg per 100 g wet weight (µg.100g<sup>-1</sup>ww).

The data were analysed using Graph Pad Prism 5 software. The results were presented as means and standard deviations. Column statistics was used for the calculation of the means, standard deviations, and the coefficients of variation. An unpaired t-test was used to evaluate the differences between the means. Statistical significance was indicated at p<0.05.

## RESULTS AND DISCUSSION

Table 1 presents the vitamin D<sub>3</sub> content in three marine (horse mackerel, turbot and garfish) and two freshwater (rainbow trout and common carp) fish species. Amounts are presented as micrograms per 100 g wet weight (µg.100g<sup>-1</sup>ww). Tabular data shows that the values of vitamin D<sub>3</sub> in the edible tissue of different fish species vary widely – 0.98 ÷ 19,7 µg.100g<sup>-1</sup>ww (Table 1).

Rainbow trout (11.4µg.100g<sup>-1</sup>ww), horse mackerel (15.7µg.100g<sup>-1</sup>ww), turbot (4.6µg.100g<sup>-1</sup>ww) and garfish (5.8µg.100g<sup>-1</sup>ww) fillets have similar values for cholecalciferol. Also similar but significantly lower are values of vitamin D<sub>3</sub> of carp (1.1µg.100g<sup>-1</sup>ww). Ostermeyer and Schmidt have shown vitamin D<sub>3</sub> content in wet fillets of rainbow trout and common carp – 7.2µg.100g<sup>-1</sup>ww and 0.98µg.100g<sup>-1</sup>ww respectively, which is in the same order as our data (Table 1).

The amounts of cholecalciferol was compared with the recommended daily intake (RDI) adopted in Bulgaria (21). Bulgarian dietary standards for average daily intake of fat soluble vitamins are close to those adopted in the European Union (2). An exception is the recommendation for daily intake of vitamin D<sub>3</sub> (5 micrograms for adults in Bulgaria – twice lower than the daily reception in the EU).

The fillets of the presented fish species produced considerably higher amounts of vitamin D<sub>3</sub> (22.0 – 314.0%). Our results show that 100 g of raw

Table 1. Vitamin D<sub>3</sub> contents in edible fish tissue (µg.100g<sup>-1</sup>ww)

Species	Vitamin D <sub>3</sub>	References
Horse mackerel ( <i>Trachurus mediterraneus</i> )	15.7±0.8*	[Merdzhanova A. et al., 2013]
	6.2±0.4	[Ostermeyer and Schmidt, 2005]
	8.7±0.5	[Dias M. et al., 2003]
	2.0±0.07	[Whole Food Catalog]
Turbot ( <i>Psetta maxima</i> )	4.6±0.5*	[Stancheva M. et al., 2012]
	2.3±0.06	[Ostermeyer and Schmidt, 2005]
Garfish ( <i>Belone belone</i> )	5.8±0.4*	[Stancheva M. et al., 2012]
	5.0±0.2	[Danish Food Composition Databank]
Rainbow trout ( <i>Oncorhynchus mykiss</i> )	11.4±0.6*	[Stancheva M. and Dobрева D.A., 2013]
	8.0±0.6	[J. Szlinder-Richert et al., 2011]
	19.7±0.9	[Kuhnlein H. et al., 2007]
	9.7±0.7	[Lu Z. et al., 2007]
	8.2±0.6	[Ostermeyer and Schmidt, 2005]
Common carp ( <i>Cyprinus carpio</i> )	19.0±0.8	[Dias M. et al., 2003]
	1.1±0.1*	[Stancheva M. and Dobрева D.A., 2013]
	7.46±0.5	[Szlinder-Richert J. et al., 2011]
	0.98±0.03	[Ostermeyer and Schmidt, 2005]

\* - own data (Bulgarian freshwater and Black Sea fish)

rainbow trout and grey mullet fillets provide about 228% and 314% vitamin D<sub>3</sub> RDI, respectively. The average value in the table data (8,0 µg.100g<sup>-1</sup>ww) represents a significant amount, compared to the RDI of this vitamin - 80% of RDI for EU countries and 160% of RDI for Bulgaria.

## CONCLUSION

Fish are a rich dietary source of fat soluble vitamin D<sub>3</sub>. The content of this micronutrient varies considerably depending on the fish species. The present study provides useful information about cholecalciferol content in some traditionally consumed fish species in Bulgaria. Most of the Bulgarian fish species provide considerable amounts of vitamin D<sub>3</sub> - a quantity almost twice as high as that of the RDI for Bulgaria. Based on the presented information we can conclude that the edible fish tissue of these species is a very good source of vitamin D<sub>3</sub>.

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