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Food of marine origin: Between benefits and potential risks. Part I. Canned fish on the Polish market

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ABSTRACT

Chemical analyses were performed on 12 of the most popular varieties of canned fish on the Polish market. The contents of the nutritive substances of canned fish (protein, micro and macroelements, vitamins A_1, D_3, E, and fatty acids) and certain contaminants were determined. It was confirmed that canned fish is a good source of digestible proteins, fluoride, iodine, selenium, and vitamin D_3. The fundamental nutritive benefit of processed fish is the highly advantageous fatty acid composition, which imparts healthful effects. The high content of long-chained polyunsaturated fatty acids, which is not noted in other food products, is especially important.

Most contaminants occurred at low levels. However, the contents of dioxins may pose a problem; although the concentrations of these pollutants in the canned products tested did not exceed permitted levels (4pg TEQ-WHO/g for dioxins/furans), they are relatively high in canned Baltic fish.

The health benefits and risks stemming from canned fish consumption were determined according to the provisional tolerable weekly intake (PTWI) for contaminants and the quantities of ingredients that render a fish diet healthy, based on data from The EFSA Journal (2005) [EFSA (European Food Safety Authority) (2005). Opinion of the scientific panel on contaminants in the food chain on a request from the European parliament related to the safety assessment of wild and farmed fish. *The EFSA Journal 236,* 1–118].

The benefits of fish and canned fish consumption outweigh the risks and the species and quantity of fish consumed is of significance to the consumer.

1. Introduction

Due to their nutritional value, fish and canned fish products are high quality foods that are beneficial to human health. The low consumption of fish and canned fish products in Poland, as compared to that in other European countries (5.8 kg/per capita, including about 1.5 kg of canned fish), is due, among other reasons, to inadequate promotion and a lack of sufficient information about their nutritional qualities.

Fish and canned fish are sources of protein rich in essential amino acids, micro and macroelements (calcium, phosphorus, fluorine, iodine), fats that are valuable sources of energy, fat-soluble vitamins, and unsaturated fatty acids that, among other benefits, have a hypocholesterolic effect (anti-arteriosclerosis) (Ismail, 2005). In comparison to the meat of slaughter animals, that of fish is rich in phosphorus, potassium and magnesium, and the calcium content of small-boned fish is also high. Marine fish and products made from them are the primary natural source of dietary iodine. They are also rich in microelements, such as selenium, fluorine and zinc.

The fundamental difference between fish and other animal or plant fats stems from its exceptionally advantageous content of fatty acids that stems from the high level of essential unsaturated fatty acids, such as docosahexaenoic (22:6, n-3, DHA), eicosapentaenoic (20:5, n-3, EPA), and docosapentaenoic (22:5, n-3, DPA).

The quantity and quality of dietary fats have recently come under scrutiny by many nutritionists and doctors due to the role these substances play in the development of some diseases and pathological states, especially in the development of cardiac and circulatory disorders. It is estimated that the consumption of one portion of fatty fish, daily, delivers about 900 mg/day of n-3 acids (e.g., EPA and DHA), and that this quantity is advantageous in reducing mortality in patients with coronary diseases (Kris-Etherton, Harris, & Appel, 2002).

In contrast to the indisputable advantages of fish in the diet, also the potential risk of exposure to the chemical contaminants contained in fish and fish products should be taken into consideration in assessment of the health quality of this food. It is well

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known that fish can contain toxic metals (mercury, arsenic, lead, and cadmium), polychlorinated biphenyls (PCBs), organochlorine pesticides, and aromatic hydrocarbons but above all else, however, fish (especially those from the Baltic) are a potential source of human exposure to such toxic contaminants as dioxin-like polychlorinated biphenyls (dl-PCBs), polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs), polybrominated diphenyl ethers (PBDEs), polychlorinated diphenyl ethers (PCDEs) or polychlorinated naphthalenes (PCNs) (Isosaari et al., 2003). Dioxins, furans, and dl-PCBs are all persistent organic pollutants (POPs) and have been classified by the International Agency for Research on Cancer (IARC) as group A carcinogens, which, places them among such substances as benzo(a)pyrene, aflatoxin, and nitrosamines. People can be exposed to POPs from various sources; however, 90% of dioxin exposure comes through food, including approximately 7% of it from fish (Piskorska-Pliszczynska, Kowalski, Wijaszka, & Grochowalski, 2005).

In recent years, investigations aimed at identifying the benefits of fish consumption have also indicated that there are risks connected with toxic contamination (Domingo, Bocio, Falo, & Llobet, 2007; Mahaffey, 2004). It is difficult to find a balance between the health benefits and risks stemming from fish consumption or even, indeed, to draw any conclusion about this issue.

The aim of the current study was to conduct tests to determine the quantity of the healthy components in canned fish (approximately 23.4% of the fish consumed in Poland is canned) as well as the contents of selected toxic substances. The second section of the paper presents the results of investigations of other fish products on the Polish market. The authors would like to contribute to the general understanding of the risks and benefits of consuming fish and fish products.

2. Materials and methods

2.1. Samples for testing

The twelve most popular varieties of canned fish on the Polish market, produced by the largest manufacturers and distributors in the country, were identified. Throughout 2005, ten different lots of each variety were collected, and each was comprised of 8–10 cans. The samples were purchased in large supermarkets, grocery stores, or directly from the manufacturers. The following varieties of canned products were chosen for the study:

1. Popular sprat in tomato sauce.
2. Sprat in oil.
3. Caro Sprat in oil.
4. Paprykarz (fish spread with rice).
5. Herring in tomato sauce.
6. Gdansk herring.
7. Herring fillets in tomato sauce.
8. Tuna in oil.
9. Mackerel fillets in tomato sauce.
10. Mackerel fillets in oil.
11. Sardine in oil.
12. Herring fillets in oil.

Tested products comprised 71.4% of the raw material used by manufacturers for production of canned fish. Moreover, 16.2% of the production was of fish spread with rice (paprykarz).

The health benefits and risks stemming from canned fish consumption were determined according to the provisional tolerable weekly intake (PTWI) for contaminants and the quantities of ingredients that render a fish diet healthy, based on data from the EFSA Journal (2005).

2.2. Study methods

2.2.1. General

Most of the chemical testing was performed at the Accredited Testing Laboratory of the Sea Fisheries Institute in Gdynia. The analyses were conducted with validated methods according to the testing procedures that are binding at the Accredited Testing Laboratory of the Sea Fisheries Institute (Accreditation Certificate no. AB 017 awarded by the Polish Center of Accreditation, in accordance with PN-EN ISO/IEC 17025:2001 standard, based on PN-EN ISO 8294 and PN-EN ISO 12193 standards.

The tests were performed as described below:

2.2.2. Mineral components

These were determined by atomic absorption spectrometry. Samples for testing the contents of most of the micro and macroelements were wet-mineralized with concentrated nitric acid in MD-2100 microwave ovens (CEM Corporation) and the final determinations were performed by the atomic absorption method in a graphite furnace with a Perkin Elmer 4100 atomic absorption spectrometer with plasma excitation, using a VISTA-MPX emission spectrometer. Mercury analysis was performed with flameless atomic absorption spectrometry, using an Altec AMA-254 spectrophotometer. Iodine and fluorine contents were assayed at the Accredited Chemical Laboratory of Multielemental Analyses at the Wrocław University of Technology. Iodine was determined by a spectrometric method, using the ICP-OES technique, and fluorine measured by means of an ion-selective electrode.

2.2.3. Fat-soluble vitamins (A_1 – all-trans-retinol, D_3 – cholecalciferol, E – α-tocopherol

The determination of fat-soluble vitamins was performed by high-performance liquid chromatography with a Merck/Hitachi chromatograph equipped with a fluorescence (for A_1 and E determination) and UV (for D_3 determination) detector. Freeze-dried samples were saponified and vitamins were extracted with hexane and then, following extraction, purification and concentration, final determinations were performed.

2.2.4. Organochlorine pesticides (OCP) and polychlorinated biphenyl (PCB_7)

Freeze-dried samples were extracted with hexane in a Soxtec Avanti apparatus. The solvent was evaporated. An aliquot of lipid was dissolved in hexane and treated with a mixture of (1:1 v/v) concentrated sulfuric acid and 30% fuming sulphuric acid for 3 h. After centrifuging and freezing the lower layer at a temperature of −50 °C, the clean hexane extract was separated and the lower layer was re-extracted with hexane. Hexane extracts were combined and the organochlorine pesticides and PCBs contained in it were assayed by capillary gas chromatography (GC-8000 gas chromatograph by Fisons) with an electron capture detector on a DB-5 column, 60 m in length. Quantification was carried out on the basis of area of standard peaks.

2.2.5. Fatty acids

Freeze-dried samples were extracted with mixture of (4:1) hexane: acetone in the Soxtec Avanti apparatus. The fatty acid contents were determined by the chromatographic method on a gas chromatograph coupled with a mass spectrometer (GC/MS – mass spectrometer by Varian, Saturn 2000) using standard mixtures. The chromatographic analysis of the fatty acids was performed after they had been put through the appropriate methyl ester. Following esterification, the purified and neutralized extracts were analyzed by the GC/MS technique with the help of a Rtx-5 MS capillary column of length of 30 m.